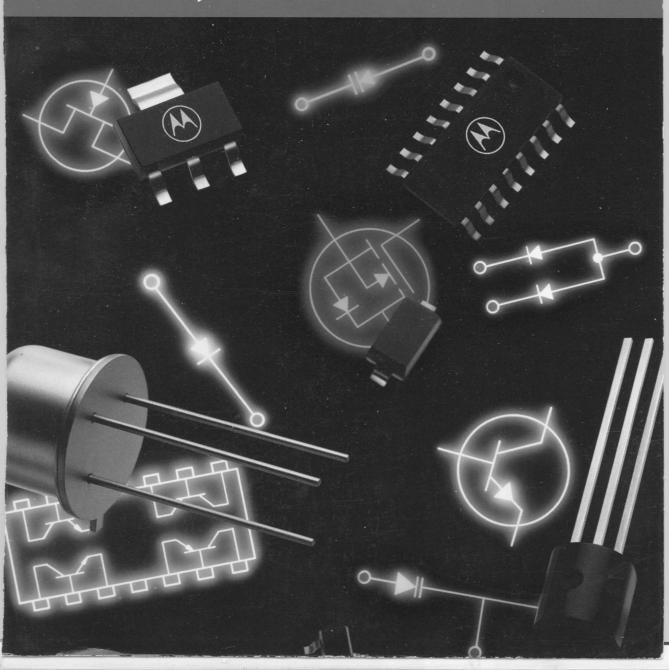
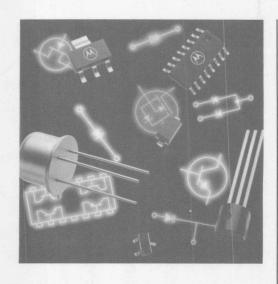


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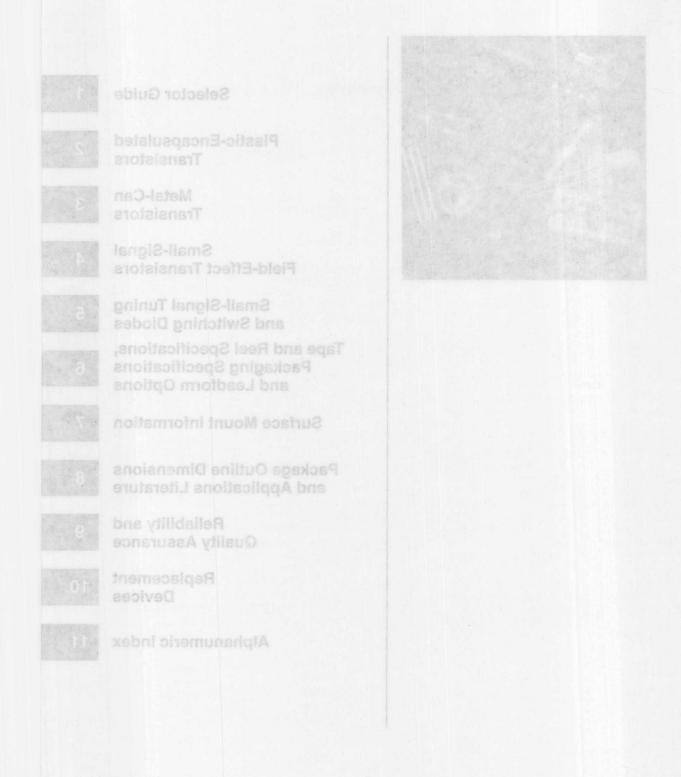
Small-Signal

Transistors, FETs and Diodes Device Data





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SMALL-SIGNAL TRANSISTORS, FETs AND DIODES

This publication presents technical information for the several product families that comprise the Motorola small-signal semiconductor line. The families include bipolar, field-effect transistors, and diodes. These are available in a variety of packages; metal can, plastic, and surface mount. Complete device specifications and typical performance curves are given on individual data sheets, which are grouped by the various families.

A quick comparison of performance characteristics is presented in the easy-to-use selector guide in the first section. The tables will assist in the selection of the proper device for a specific application.

Separate sections are included to describe package outline drawings and footprints and product reliability and quality considerations.

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E-FET is a trademark of Motorola, Inc.

I Clad is a registered trademark of the Bergguist Compared trademark of Motorola, Inc.

#901 and slotofold of Thermal Clad is a registered trademark of the Bergquist Company

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About This Revision

To accommodate the increasing requirements for surface mount components, this publication adds a variety of device types in several choices of surface mount packages.

- Bias Resistor Transistor selections have been expanded to eleven specifications available in three package types: SC-59, SOT-23 and SC-70/SOT-323 (Section 2).
- Expanded portfolio of mid-power SOT-223 devices (Section 2).
- New series of low-leakage medium-speed switching diodes designed for energy conservation in battery-powered applications (Section 5).
- An offering of the most–needed switching and Schottky diode specifications in the 2–leaded SOD–123 surface mount package (Section 5).

It should be noted that medium–power TMOS FETs formerly listed in this data book can now be found in the *Motorola TMOS Power MOSFET Transistors Device Data* book.

Motorola Device Classifications

In an effort to provide current information to the customer regarding the status of any given device, Motorola has classified all devices into three categories: Preferred devices, Current product and Not Recommended for New Design products.

A Preferred device is a device which is recommended as a first choice for future use. These devices are "preferred" by virtue of their performance, price functionality, or combination of attributes which offer the overall "best" value to the customer. This category contains both advanced and mature devices which will remain available for the foreseeable future (generally 3 to 5 years).

All Small-Signal transistors, FETs, or Diodes that are classified as a "preferred device" have a star symbol (*) at the end of the device title on the individual data sheets.

Device types identified as "current" are not a first choice product for **new** designs, but will continue to be available because of the popularity and/or standardization or volume usage in current production designs. These products can be acceptable for new designs but the preferred types are considered better alternatives for long term usage.

Any device that has not been identified as a "preferred device" is a "current" device.

Products designated as "Not Recommended for New Design" may become obsolete as dictated by poor market acceptance, or a technology or package that is reaching the end of its life cycle. Devices in this category have an uncertain future and do not represent a good selection for new device designs or long term usage.

All "Not Recommended for New Design" devices have been removed from the data book. In the event the device you need is no longer found within an appropriate section of the data book, refer to the Replacement Devices index at the back of the book to see if there is a Replacement Part for the device in question.

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Section 1 Selector Guide

In Brief . . .

This selector guide highlights semiconductors that are the most popular and have a history of high usage for the most applications.

It covers a wide range of Small-Signal plastic and metal-can semiconductors.

A large selection of encapsulated plastic transistors, FETs and diodes are available for surface mount and insertion assembly technology. Plastic packages include TO-92 (TO-226AA), 1 Watt TO-92 (TO-226AE), SOT-23, SC-70/SOT-323, SC-59, SOD-123, and SOT-223. Plastic multiples are available in 14-pin and 16-pin dual-in-line packages for insertion applications: SO-14 and SO-16 for surface mount applications.

Metal-can packages are available for applications requiring higher power dissipation or having hermetic requirements in TO-18 (TO-206AA) and TO-39 (TO-205AD).

Bipolar Transistors

Plastic-Encapsulated Transistors

Motorola's Small Signal TO–226 plastic transistors encompass hundreds of devices with a wide variety of characteristics for general–purpose, amplifier and switching applications. The popular high–volume package combines proven reliability, performance, economy and convenience to provide the perfect solution for industrial and consumer design problems. All devices are laser marked for ease of identification and shipped in antistatic containers, as part of Motorola's ongoing practice of maintaining the highest standards of quality and reliability.



Table 1. Plastic-Encapsulated General-Purpose Transistors

These general—purpose transistors are designed for small—signal amplification from dc to low ratio frequencies. They are also useful as oscillators and general—purpose switches. Complementary devices shown where available (Tables 1–4).

		Vannossa	f _T @	Ic	Ic	olhsani bol	hFE @ IC	ole for surfa	NF	d dioded
NPN	PNP	V(BR)CEO Volts Min	MHz Min	mA	mA Max	Min	Max	mA	dB Max	Style
Case 29-04	— TO-226A	A (TO-92)			sack-	enil-ni-lisu	binig-81 bri	in M-pin a	eldaliave a	liplos a
MPS8099	MPS8599	80	150	10	500	100	300	1.0	qqs <u>n</u> o.ha	ni 101 ₁ 86
MPSA06	MPSA56	80	100	10	500	100	_	100	cations.	cus Hu
2N4410		80	60	10	250	60	400	10	n pa <u>ck</u> age	80-1040
BC546	BC556	65	150	10	100	120	450	2.0	10	17
BC546A	_	65	150	10	100	120	220	2.0	10	17
BC546B	BC556B	65	150	10	100	180	450	2.0	10	17
MPSA05	MPSA55	60	100	10	500	100	_	100	_	1
	MPS2907A	60	200	50	600	100	300	150	_	1
BC182	BC212	50	200(1)	10	100	120	500	2.0	10	14
BC237B	BC307B	45	150	10	100	200	460	2.0	10	17
BC337	BC327	45	210(1)	10	800	100	630	100	_	17
BC547	BC557	45	150	10	100	120	800	2.0	10	17
BC547A	BC557A	45	150	10	100	120	220	2.0	10	17
BC547B	BC557B	45	150	10	100	180	450	2.0	10	17
BC547C	BC557C	45	150	10	100	380	800	2.0	10	17
MPSA20	MPSA70	40	125	5.0	100	40	400	5.0		1
MPS2222A		40	300	20	600	100	300	150	_ 8 *	1
2N4401	2N4403	40	200	20	600	100	300	150	_	1
2N4400	2N4402	40	150	20	600	50	150	150	_	1
MPS6602	MPS6652	40	100	50	1000	50	_	500	_	1
2N3903	2N3905	40	200	10	200	50	150	10	6.0	1
2N3904	2N3906	40	250	10	200	100	300	10	5.0	1
BC548	_	30	300(1)	10	100	110	800	2.0	10	17
BC548A		30	300(1)	10	100	120	220	2.0	10	17
BC548B	BC558B	30	300(1)	10	100	200	450	2.0	10	17
BC548C		30	300	10	100	420	800	2.0	10	17
2N4123	2N4125	30	200	10	200	50	150	2.0	6.0	1
2N4124	2N4126	25	250	10	200	120	360	2.0	4.0	1
BC338	BC328	25	210(1)	10	800	100	630	100	_	17

⁽¹⁾ Typical

Table 1. Plastic-Encapsulated General-Purpose Transistors (contin

	pedance.	V(BR)CEO	f _T (@ IC	Ic	olisoliqu	hFE @ IC	nelatora o	VCE(s	at) @ Ic @	IB IB	adingt
NPN	PNP	Volts	MHz Min	mA	A Max	Min	Max	mA	Volts Max	mA	mA	Style
SHIPTER .	Total Control	SAE (1-WAT	520		800		1	l of	BR)CED)V		Days and
BDB01D	BDB02D	100	50	200	0.5	40	400	100	0.7	1000	100	1
BDC01D	BDC02D	100	50	200	0.5	40	400	100	0.7	1000	100	14
BDB01C	BDB02C	80	50	200	0.5	40	400	100	0.7	1000	100	1
MPS6717	os i our	80	50	200	0.5	80	2885	50	0.5	250	10	1
MPSW06	MPSW56	80	50	200	0.5	80	0408	50	0.4	250	10	- 4

Table 2. Plastic-Encapsulated Low-Noise and Good hee Linearity

These devices are designed to use on applications where good hee linearity and low-noise characteristics are required: Instrumentation, hi-fi preamplifier.

	+	0.1	1.6	hFE @ IC		V _T (4)	NF(5)	MPSAZE	
NPN	PNP	V _(BR) CEO Volts	opa Min	Max	mA	mV Typ	dB Max	f _T MHz Typ	Style
Case 29-04	1 — TO-226	AA (TO-92)	100	1001		NOT DOS	90	MARSAGS	MPSA13
	2N5087	50	250	800	0.1	-	2.0	40(2)	1
1-	2N5086	50	150	500	0.1		3.0	40(2)	1 1
MPS6428	_	50	250	650	0.1	7.0(7)	3.5(8)	100(2)	4 4 4 (108)
BC239	-signal trans	45	120	800	2.0	9.5	2.0(1)	280	17
BC550B	BC560B	45	180	450	2.0	10-	2.5	250	17
BC550C	BC560C	45	380	800	2.0	9 7 1 -	2.5	250	17
MPSA18	_	45	500		1.0	6.5(1)	allolf -	160	1
MPS3904	MPS3906	40	100	300	10	1200	5.0	200(2)	11911
_	MPS4250	40	250	-	10	(50-07	2.0	Sec. 777	n_ec1
BC549B	BC559B	30	200	450	2.0	Value on a	2.5	250	17
BC549C	BC559C	30	380	800	2.0	-	2.5	250	17
2N5088	1000-	30	350	GL 0	1.0	02	3.0	50	AFON SHIP
2N5089(6)	_	25	450	_	1.0	_	2.0	50	1
MPS6521	MPS6523	25	300	600	2.0	_	3.0	033-01	1

¹ Typical (2) Min (4) V_T: Total Input Noise Voltage (see BC413/BC414 and BC415/BC416 Data Sheets) at R_S = 2.0 k Ω , I_C = 200 μ A, V_{CE} = 5.0 Volts. (5) N_F: Noise Figure at R_S = 2.0 k Ω , I_C = 200 μ A, V_{CE} = 5.0 Volts. f = 30 Hz to 15 kHz. (7) R_S = 10 k Ω , BW = 1.0 Hz, f = 100 MHz (8) R_S = 500 Ω , BW = 1.0 Hz, f = 10 MHz

Plastic-Encapsulated Transistors (continued)

Table 3. Plastic-Encapsulated Darlington Transistors

Darlington amplifiers are cascade transistors used in applications requiring very high—gain and input impedance. These devices have monolithic construction.

	m Am	X8M -	Am		hFE @ IC) X5	VCE	(sat) @ Ic	& IB	f _T @	lc lc	ИЗИ
NPN	PNP	V _(BR) CEO Volts	I _C Max	Min	Max	mA	Volts Max	mA	mA	Min	mA	Style
Case 29-05	— TO-22	6AE (1-WAT	T TO-92	2)	40	8.0	200	00	100	0200	ooa -	Grobat
MPSW45A	0000	50	1000	25K	150K	200	1.5	1000	2.0	100	200	1
	MPSW64	30	1000	20K	-08-	100	1.5	100	0.1	125	10	1
Case 29-04	4 — TO-22	6AA (TO-92)	7								
MPSA29	_	100	500	10K	yal lu tan	100	1.5	100	0.1	125	10	0.18
BC373	en e ur seite	80	1000	10K	160K	100	1.1	250	0.25	100	100	1
MPSA27	MPSA77	60	500	10K	-	100	1.5	100	0.1	Day II.	mollistee	1
BC618		55	1000	10K	50K	200	1.1	200	0.2	150	500	17
	MPSA75	40	500	10K	-	100	1.5	100	0.1	-	-	1
2N6427	-1	40	500	20K	200K	100	1.5	500	0.5	-	+	1
2N6426	41/30	40	500	30K	300K	100	1.5	500	0.5	125	10	1
MPSA14	MPSA64	30	500	20K	800	100	1.5	100	0.1	125	10	1919
MPSA13	MPSA63	30	500	10K	-	100	1.5	100	0.1	125	10	1
BC517	_	30	1000	30K		20	1.0	100	0.1	200(1)	10	17

Table 4. Plastic-Encapsulated High-Current Transistors

The following table is a listing of devices that are capable of handling a higher current range for small-signal transistors.

	089	V(BR)CEO	f _T @ I	C	Ic	GOS I	FE @ I		VCE(s	at) @ Ic 8	lB	2000000
NPN	NPN PNP	Volts	MHz Min	mA	mA Max	Min	Max	mA	Volts Max	mA	mA	Style
Case 29-05	— TO-226	AE (1-WATT	TO-92)	.01		rista.	1	22	40	S4250	9.00	001200
MPS6715	MPS6727	40		-0.0	1000	50	-	1000	0.5	1000	100	110
MPSW01A	MPSW51A	40	50	50	1000	50	- 0	1000	0.5/0.7	1000	100	moda.
Case 29-04	— TO-226/	AA (TO-92)		0.		doo	1 2	(III)	25	66393	GM 40	80.06MS
BC489	BC490	80	200/150(1)	50	1000	60	400	100	0.3/0.5	1000	100	17
BC639	BC640	80	60	10	500	40	160	150	0.5	500	50	14
MPS651	MPS751	60	75	50	2000	75	ra os po	1000	0.5	2000	200	-v 1
MPS650	MPS750	40	75	50	2000	75	cv od =	1000	0.5	2000	200	1
BC368	BC369	20	65	10	1000	60	_ :	1000	0.5	1000	100	1

⁽¹⁾ Typical

Plastic-Encapsulated Transistors (continued) (Description) and the substantial baselines (Encapsulated Transistors (continued) (Description) and the substantial baselines (Encapsulated Transistors (Continued) (Description) (Encapsulated Transistors (Encapsulated Transistor) (Encapsulated Transistors (En

Table 5. Plastic-Encapsulated High-Voltage Amplifier Transistors

These high-voltage transistors are designed for driving neon bulbs and indicator tubes, for direct line operation, and for other applications requiring high-voltage capability at relatively low collector current. These devices are listed in order of decreasing breakdown voltage (V(BR)CFO).

	V _{(BR)CEO}	Ic	hFE	@ IC	VCE	(sat) @ Ic	& IB	f _T @	₽ IC	anliveC
Device Type	Volts Min	Amp Max	Min	mA	Volts Max	mA	mA	MHz Min	mA	Style
Case 29-0	5 — TO-226	AE (1-WA	TT TO-92)	— NPN	68	05 1	ne T	02 T	- Br	5,00
BDC05	300	0.5	40	25	2.0	20	2.0	60	10	14
MPSW42	300	0.5	40	30	0.5	20	2.0	50	10	01/189
Case 29-0	5 — TO-226	AE (1-WA	TT TO-92)	— PNP	10	3.0	20	100	30	SHQTA(2)
MPSW92	300	0.5	25	30	0.5	20	2.0	50	10	11/485
Case 29-0	04 — TO-226	AA (TO-92	2) — NPN	(A)Gen	10	4.0	- 00 - 0k	- Note	25	0149
BF844	400	0.3	50	10	0.5	10	1.0	- 0.01	-	1000
MPSA44	400	0.3	40	100	0.75	50	5.0		-	11425
2N6517	350	0.5	30	30	0.3	10	1.0	40	10	100
BF393	300	0.5	40	10	0.2	20	2.0	50	10	extass
MPSA42	300	0.5	40	10	0.5	20	2.0	50	10	£122
2N5551	160	0.6	80	(\$) 10	0.15	10	1.0	100	10	- actas
Case 29-0	04 — TO-226	AA (TO-9	2) — PNP				- PNP	(SE-OT) AA	- TO-286	se 29-04
BF493S	350	0.5	40	(\$)10	20	20	2.0	50	10	rdiago
2N6520	350	0.5	30	30	0.3	10	1.0	40	10	1.00
MPSA92	300	0.5	40	10	0.5	20	2.0	50	10	1
2N6519	300	0.5	45	30	0.3	10	1.0	40	10	1
2N5401	150	0.6	60	10	0.2	10	1.0	100	10	114 -7 010

Case 29-04 — TO-226AA (TO-92)

	Am i	V(BR)CEO	Ic	hFE	@ Ic	VCE	(sat) @ IC	& IB	f _T €	₽ IC	earve
NPN	PNP	Volts Min	Amp Cont	Min	mA	Volts Max	mA	mA	MHz Min	mA	Style
BF420	BF421	300	0.5	50	25	2.0	20	2.0	60	10	14
BF422	BF423	250	0.5	50	25	2.0	20	2.0	60	10	14

Plastic-Encapsulated Transistors (continued) (September 1) and telegraph 3-0 fast9

Table 6. Plastic-Encapsulated RF Transistors

The RF transistors are designed for small-signal amplification from RF to VHF/UHF frequencies. They are also used as mixers and oscillators in the same frequency ranges.

	Vannosa	lo		hFE @ IC		fT	CRE/CRB	NF	HARMONIO	SUPPRINT
Device Type	V(BR)CEO Volts Min	Max	Min	mA	VCE	MHz Typ	pF Max	dB Typ	f MHz	Style
Case 29-04	— TO-226A	A (TO-92)	— NPN	Am	Abwi	Atti	AUR	XSSHID	71100	edá
BF224	30	50	30	7.0	10	600	0.28	2.5	100	21
MPSH24	30	50	30	8.0	10	400(2)	0.36	3.0	000	200
MPSH20	30	100	25	4.0	10	400(2)	0.65	34	300	2
MPSH07A(9)	30	25	20	3.0	10	400(2)	0.3	3.2(3)	100	. 1
MPS3866	30	400	10	50	5.0	500(2)	26-01 119	44-17 SHO	22-01-	1
MPSH11	25	10-05	60	4.0	10	650(2)	0.9	3.0	000	2
MPSH10	25	_	60	4.0	10	650(2)	0.65	100 A 60	NO. 157	2
BF199	25	100	40	7.0	10	750	0.35	2.5	35	21
BF959	20	100	40	20	10	600(2)	0.65	3.0	200	21
MPSH17	15	-	25	5.0	10	800(2)	0.9	6.0(3)	200	2
MPS918	15	50	20	8.0	10	600(2)	1.7	6.0(3)	60	4.99
MPS5179	12	50	25	3.0	1.0	2000(3)	08	5.0(3)	200	1086
MPS3563	12	50	20	8.0	10	800	1.7	6.0(3)	60	SAMIS
MPS6595	12	50	25	10	5.0	1200(2)	1.3	80	ear	11000
Case 29-04	— TO-266A	A (TO-92)	— PNP				92) — PNP	HOT) AAR	TO-22	PO-05 6
MPSH81	20	50	60	5.0	10	600(2)	0.85	<u>A</u> 5	350	2
MPSH69	15	50	30	10	10	2000(2)	0.3	0.5	(928)	9,38

Table 7. Plastic-Encapsulated High-Speed Saturated Switching Transistors

	to	n & toff @	IC	V _{(BR)CEO}	hFE	@ Ic	VCE	sat) @ IC	& IB	fT	@ Ic	aso 29-0
Device Type	ns Max	ns Max	mA	Volts	Min	mA	Volts Max	mA	mA	MHz Min	mA	Style
Case 29-04	— TO-22	26AA (TO-	-92) — N	IPN	VI.	Am	niM	Amp	initia .		PMP	14300
2N4264	25	35	10	15	40	10	0.22	10	1.0	300	10	1,000
2N4265	25	35	10	12	100	10	0.22	10	1.0	300	10	1
MPS3646	18	28	300	15	30	30	0.2	30	3.0	350	30	1
MPS2369A	12	18	10	15	40	10	0.2	10	1.0	_	_	1
Case 29-04	— TO-22	26AA (TO	-92) — P	NP								
MPS4258	15	20	10	12	30	50	0.15	10	1.0	700	10	1

⁽²⁾ Min (3) Max (9) AGC Capable

Plastic-Encapsulated Transistors (continued)

Table 8. Plastic-Encapsulated Choppers

Devices are listed in decreasing V/RR\FRO

	V(BR)EBO	lc s	hFE	@ Ic	VCE	E(sat) @ Ic	& IB	fr @ Ic		a quitum en
Device Type	Volts Min	I _C Amp(1) Max	Min	mA	Volts Max	mA	mA	MHz Min	mA	Style
Case 29-04	1 — TO-226A	A (TO-92)	— NPN	* 5	8101	alen stransis	igid 9M9 b	ne Man	nall-signa	ludes sr
MPSA17	15	100	200	5.0	0.25	10	1.0	80	5.0	on Allo
MPSA16	12	100	200	5.0	0.25	10	1.0	100	5.0	1
Case 29-04	1 — TO-266A	A (TO-92)	— PNP							
MPS404A	-25	-150	30	-12	-0.2	-24	1.0	-		1

Table 9. Plastic-Encapsulated Telecom Transistors

These devices are special product ranges intended for use in telecom applications.

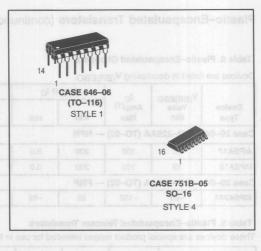
	nebro onem	P _D mW	lc lotal	ment laufi Dual	hFE @	IC @ VCE	ishilbana mi	fT	wallot er
Device Type	V _{(BR)CEO} Volts	25°C Amb	mA Cont	Min	Max	mA	MHz A Volts Min	The second of the second	Style
Case 29-04 — TO-226	SAA (TO-92)	— NPN		VBN				THE	
P2N2222A PBF259,S(10)	40 300	625 625	600 500	75 25	T	10	10 10	300 40	17
Case 29-04 — TO-226	SAA (TO-92)	— PNP	1 2 17				09		
P2N2907A PBF493,S(11)	60 300	625 625	600 500	100	9	10	10	200 40	17

(1) Typical (10) "S" version, hFE Min 60 @ I $_{\rm C}$ = 20 mA, V $_{\rm CE}$ = 10 V. (11) "S" version, hFE Min 40 @ I $_{\rm C}$ = 0.1 mA, V $_{\rm CE}$ = 1.0 V.

Plastic-Encapsulated Multiple Transistors

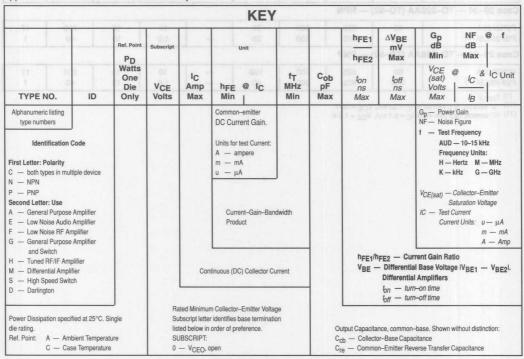
The manufacturing trend has been toward printed circuit board design with requirements for smaller packages with more functions. In the case of discrete components the use of the multiple device package helps to reduce board space requirements and assembly costs.

Many of the most popular devices are offered in the standard plastic DIP and surface mount IC packages. This includes small-signal NPN and PNP bipolar transistors, N-channel and P-channel FETs, as well as diode arrays.



Specification Tables

The following short form specifications include Quad and Dual transistors listed in alphanumeric order. Some columns denote two different types of data indicated by either **bold** or *italic* typeface. See key and headings for proper identification. This applies to Table 10 and 11 of this section only.



Plastic-Encapsulated Multiple Transistors (continued)

Table 10. Plastic-Encapsulated Multiple Transistors — Quad

The following table is a listing of the most popular multiple devices available in the plastic DIP package. These devices are available in NPN, PNP, and NPN/PNP configurations. (See note.)

			D-230AL	Telepin Indian	lifty and	disilen eo	hFE1	∆VBE mV	G _p	NF (@ f
	P _D Watts		and the		Jana Du	arture a	hFE2	Max	Min	Max Typ(1)	s tic
ID	One Die	VCEO	I _C Amp Max	hFE @ IC	f _T MHz Min	C _{ob} pF	ton ns	t _{off}	VCE (sat) Volts	@ IC	Ic

Case 646-06 - TO-116

MPQ2222A	NA	0.65	40	0.5	100	150 m	200	8.0	35(1)	285(1)	0.3	10	150 m
MPQ2369	NS	0.5	15	0.5	40	10 m	450	4.0	9.0(1)	15(1)	0.25	10	10 m
MPQ2483	NA	0.625	40	0.05	150	1.0 m	50					3.0(1)	AUD
MPQ2484	NA	0.625	40	0.05	300	1.0 m	50		74.5			2.0(1)	AUD
MPQ2907A	PA	0.65	60	0.6	100	150 m	200	8.0	45(1)	180(1)	0.4	10	150 m
MPQ3467	PS	0.75	40	1.0	20	500 m	125	25	40	90	0.5	10	500 m
MPQ3725	NS	1.0	40	1.0	25	500 m	250	10	35	60	0.45	10	500 m
MPQ3762	PS	0.75	40	1.5	35	150 m	150	15	50	120	0.55	10	500 m
MPQ3798	PA	0.625	40	0.05	150	0.1 m	60	4.0	alesien d	MITH STERRY		3.0(1)	AUD
MPQ3799	PA	0.625	60	0.05	300	0.1 m	60	4.0	101091	00-E 119		2.0(1)	AUD
MPQ3904	NG	0.5	40	0.2	75	10 m	250	4.0	37(1)	136(1)	0.2	10	10 m
MPQ3906	PG	0.5	40	0.2	75	10 m	200	4.5	43(1)	155(1)	0.25	10	10 m
MPQ6001	CG	0.65	30	0.5	40	150 m	200	8.0	30(1)	225(1)	0.4	10	150 m
MPQ6002	CG	0.65	30	0.5	100	150 m	200	8.0	30(1)	225(1)	0.4	10	150 m
MPQ6100A	CA	0.5	45	0.05	150	1.0 m	50	4.0	1-(88-	TOS) BA	HES-OT	4.0(1)	AUD
MPQ6426	ND	0.5	30	0.5	10K	100 m	125	8.0	-	_	1.5	10	100 m
MPQ6501	CG	0.65	30	0.5	40	150 m	200	8.0	30(1)	225(1)	0.4	10	150 m
MPQ6502	CG	0.65	30	0.5	100	150 m	200	8.0	30(1)	225(1)	0.4	10	150 m
MPQ6600A1	CA	0.5	45	0.05	150	1.0 m	50	4.0	0.8	20	0.25	10	1.0 m
MPQ6700	CA	0.5	40	0.2	70	10 m	200	4.5		- 66	0.25	10	1.0 m
MPQ6842	CA	0.75	40	0.5	70	10 m	300	4.5	45	150	0.15	10	0.5 m
MPQ7043	NA	0.75	250	0.5	25	1.0 m	50	5.0		(3)	0.5	10	20 m
MPQ7042	NA	0.75	200	0.5	25	1.0 m	50	5.0		- 40	0.5	10	20 m
MPQ7051	CG	0.75	150	0.5	25	1.0 m	50	6.0		10	0.7	10	20 m
MPQ7093	PA	0.75	250	0.5	25	1.0 m	50	5.0		93	0.5	10	20 m

Table 11. Plastic-Encapsulated Multiple Transistors — Quad Surface Mount

The following table is a listing of the most popular multiple devices available in the plastic SOIC surface mount package. These devices are available in NPN, PNP, and NPN/PNP configurations.

			h	FE @ IC	fT	@ Ic
Device	V(BR)CEO	V(BR)CBO	Min	mA	MHz Min	mA
Case 751B-05 — SO-16	475	020		20	88	TTJEBREOM
MMPQ2222A	40	75	40	500	200	20
MMPQ2369	15	40	20	100	450	10
MMPQ2907A	50	60	50	500	200	50
MMPQ3467	40	40	20	500	125	50
MMPQ3725	40	60	25	500	250	50
MMPQ3799	60	60	300	0.5	60	1.0
MMPQ3904	40	60	75	10	250	10
MMPQ3906	40	40	75	10	200	10
MMPQ6700(12)	40	40	70	10	200	10

⁽¹⁾ Typical

NOTE: Some columns show 2 different types of data indicated by either **bold** or *italic* typefaces. See key and headings.

⁽¹²⁾ NPN/PNF

Plastic-Encapsulated Surface Mount Transistors

This section of the selector guide lists the small–signal plastic devices that are available for surface mount applications. These devices are encapsulated with the latest state–of–the–art mold compounds that enhance reliability and exhibit excellent performance in high temperature and high humidity environments. This package offers higher power dissipation capability for small–signal applications.

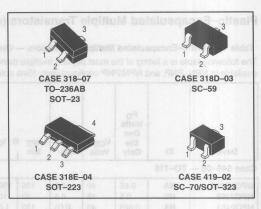


Table 12. Plastic-Encapsulated Surface Mount General-Purpose Transistors

The following tables are a listing of small–signal general–purpose transistors in the SOT–23 and SC–59 surface mount packages. These devices are intended for small–signal amplification for DC, audio, and lower RF frequencies. They also have applications as oscillators and general–purpose, low voltage switches.

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

Device Marking V(BR)CEO Min Max mA Case 318-07 — TO-236AB (SOT-23) — NPN BC846ALT1 1A 65 110 220 2.0 BC846BLT1 1B 65 200 450 2.0 BC817-16LT1 6A 45 100 250 100 BC817-25LT1 6B 45 160 400 100 BC847-25LT1 6C 45 250 600 100 BC847ALT1 1E 45 110 220 2.0 BC847BLT1 1F 45 200 450 2.0 BC847CLT1 1G 45 420 800 2.0 MMBT3904LT1 1AM 40 100 300 150 MMBT3904LT1 1X 30 110 220 2.0 BC848ALT1 1X 30 200 450 2.0 BC848BLT1 1K 30 20 450 2.0	fT
BC846ALT1	MHz Min
BC846BLT1	Agorago
BC846BLT1 1B 65 200 450 2,0 BC817-16LT1 6A 45 100 250 100 BC817-25LT1 6B 45 160 400 100 BC817-40LT1 6C 45 250 600 100 BC847BLT1 1E 45 110 220 2.0 BC847BLT1 1F 45 200 450 2.0 BC847BLT1 1G 45 420 800 2.0 MMBT3222ALT1 1P 40 100 300 150 MMBT3904LT1 1AM 40 100 300 150 MMBT3904LT1 1J 30 110 220 2.0 BC848BLT1 1K 30 200 450 2.0 BC848BLT1 1K 30 200 450 2.0 BC848CLT1 1L 30 420 800 2.0 Case 318-07 — TO-236AB (SOT-23) — PNP <t< td=""><td>100</td></t<>	100
BC817-25LT1 6B 45 160 400 100 BC817-40LT1 6C 45 250 600 100 BC847ALT1 1E 45 110 220 2.0 BC847BLT1 1F 45 200 450 2.0 BC847BLT1 1G 45 420 800 2.0 BC847CLT1 1P 40 100 300 150 MMBT2222ALT1 1AM 40 100 300 150 BC848ALT1 2X 40 100 300 150 BC848ALT1 1X 30 110 220 2.0 BC848BLT1 1X 30 200 450 2.0 BC848BLT1 1	100
SC817-40LT1	200
### BC847ALT1	200
### BC847BLT1	200
### ### ### ### ### ### ### ### ### ##	100
### BC847CLT1	100
MMBT2222ALT1 1P 40 100 300 150 MMBT3904LT1 1AM 40 100 300 10 MMBT3904LT1 2X 40 100 300 150 BC848ALT1 1J 30 110 220 2.0 BC848BLT1 1K 30 200 450 2.0 BC848CLT1 1L 30 420 800 2.0 Case 318-07 — TO-236AB (SOT-23) — PNP VMBT8599LT1 2W 80 100 300 1.0 BC856ALT1 3A 65 125 250 2.0 BC856BLT1 3B 65 220 475 2.0 MMBT2907ALT1 2F 60 100 300 150 BC807-16LT1 5A 45 100 250 100	100
MMBT4401LT1 2X 40 100 300 150 BC848ALT1 1J 30 110 220 2.0 BC848BLT1 1K 30 200 450 2.0 BC848CLT1 1L 30 420 800 2.0 Case 318-07 — TO-236AB (SOT-23) — PNP MMBT8599LT1 2W 80 100 300 1.0 BC856ALT1 3A 65 125 250 2.0 BC856BLT1 3B 65 220 475 2.0 MMBT2907ALT1 2F 60 100 300 150 BC807-16LT1 5A 45 100 250 100	200
### BC848ALT1	200
### BC848BLT1	250
### BC848CLT1	100
Case 318-07 — TO-236AB (SOT-23) — PNP MMBT8599LT1	100
MMBT8599LT1 2W 80 100 300 1.0 BC856ALT1 3A 65 125 250 2.0 BC856BLT1 3B 65 220 475 2.0 MMBT2907ALT1 2F 60 100 300 150 BC807-16LT1 5A 45 100 250 100	100
BC856ALT1 3A 65 125 250 2.0 BC856BLT1 3B 65 220 475 2.0 MMBT2907ALT1 2F 60 100 300 150 BC807—16LT1 5A 45 100 250 100	
BC856BLT1 3B 65 220 475 2.0 MMBT2907ALT1 2F 60 100 300 150 BC807—16LT1 5A 45 100 250 100	150
MMBT2907ALT1 2F 60 100 300 150 BC807-16LT1 5A 45 100 250 100	100
BC807–16LT1 5A 45 100 250 100	100
\$0	200
	200
	ATTRICTURE

Table 12. Plastic-Encapsulated Surface Mount General-Purpose Transistors (continued)

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

		al Stand		hFE @ IC		fT
Device	Marking	V(BR)CEO	Min	Max	mA	MHz Min
Case 318-07 — To	0-236AB (SOT-2	23) — PNP	(0(86)	SMA MAIN	प्राप्त	Balk
BC807-25LT1	5B	45	160	400	100	200
BC807-40LT1	5C	45	250	600	100	200
BC857ALT1	3E	45	125	250	2.0	100
BC857BLT1	3F	45	220	475	2.0	100
MMBT3906LT1	2A	40	100	300	10	250
MMBT4403LT1	901 2T	40	100	300	150	200
BC858ALT1	3J 0	30	125	250	2.0	100
BC858BLT1	3K	30	220	475	2.0	100
BC858CLT1	3L	30	420	800	2.0	100
Case 318D-03 —	SC-59 — NPN	10	00	ASA ASA SEA	YTATYTSAUAGA	MUNEZYILTT 1 MUNEZZIZITT 1
MSD601-RT1	COL YR O	25	210	340	2.0	150(1)
MSD601-ST1	YS O	25	290	460	2.0	150(1)
MSD602-RT1	WR 0	25	120	240	150	200(1)
MSD1328-RT1	oor 1DR	20	200	350	500	200(1)
Case 318D-03 —	SC-59 — PNP	80 8	90	HBA DRA	VILITE ESMISSIONES	MIDNESSULET MILMISSSYLTY
MSB709-RT1	AR DA	25	210	340	2.0	100(1)
MSB709-ST1	AS	25	290	460	2.0	100(1)
MSB710-QT1	CQ	25	85	170	150	200(1)
MSB710-RT1	CR	25	120	240	150	200(1)
Case 419-02 - S	C-70/SOT-323 -	-NPN	02	AB AB	ALTH ENTINE	TITTERWEE
MSD1819A-RT1	ZR	50	210	340	2.0	100
Case 419-02 — S	C-70/SOT-323 -	-PNP	68	Ga Ga	MUNISTRATT	
MSB1218A-RT1	AR	45	310	340	2.0	100
(1) Typical	1 40	200	90	10	STATE AND ADDRESS OF THE PARTY	170120110

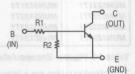


Table 13. Plastic-Encapsulated Surface Mount Bias **Resistor Transistors for General Purpose Applications**

These devices include bias resistors on the semiconductor chip with the transistor. See the BRT diagram for orientation of resistors.

D	evice	Marking		V(BR)CEO Volts	hFE	@ IC	Ic	R ₁	R ₂
NPN	PNP	NPN	PNP	(Min)	Min	- (EmA	Max	Ohm	Ohm
Case 318D-03	3 — SC-59	20 -	8	18	SI	Lil		TTANS	ESTEM
MUN2211T1	MUN2111T1	8A	6A	50	35	5.0	100	10K	10K
MUN2212T1	MUN2112T1	8B	6B	50	60	5.0	100	22K	22K
MUN2213T1	MUN2113T1	8C	6C	50	80	5.0	100	47K	47K
MUN2214T1	MUN2114T1	8D	6D	50	80	5.0	100	10K	47K
MUN2215T1	MUN2115T1	8E	6E	50	160	5.0	100	10K	00

Table 13. Plastic–Encapsulated Surface Mount Bias
Resistor Transistors for General–Purpose Applications (continued)

Pinout: 1-Base, 2-Emitter, 3-Collector

Dev	vice	Mark	ding	V(BR)CEO Volts	hFE	@ IC	Ic	D.	
NPN	PNP	NPN	PNP	(Min)	Min	mA	mA Max	R ₁ Ohm	R ₂ Ohm
Case 318D-03	— SC-59	400		par	45		8a	7738	S-Triell
MUN2216T1	MUN2116T1	8F 000	6F	50	160	5.0	100	4.7K	∞
MUN2230T1	MUN2130T1	8G	6G	50	3.0	5.0	100	1.0K	1.0K
MUN2231T1	MUN2131T1	8H	6H	50	8.0	5.0	100	2.2K	2.2K
MUN2232T1	MUN2132T1	8J 000	6J	50	15	5.0	100	4.7K	4.7K
MUN2233T1	MUN2133T1	8K	6K	50	80	5.0	100	4.7K	47K
MUN2234T1	MUN2134T1	8L	6L	50	80	5.0	100	22K	47K
Case 318-07 -	TO-236AB (SOT	-23)		420	36		III.	17.	1088801
MMUN2211LT1	MMUN2111LT1	A8A	A6A	50	35	5.0	100	10K	10K
MMUN2212LT1	MMUN2112LT1	A8B	A6B	50	60	5.0	100	22K	22K
MMUN2213LT1	MMUN2113LT1	A8C	A6C	50	80	5.0	100	47K	47K
MMUN2214LT1	MMUN2114LT1	A8D	A6D	50	80	5.0	100	10K	47K
MMUN2215LT1	MMUN2115LT1	A8E	A6E	50	160	5.0	100	10K	00
MMUN2216LT1	MMUN2116LT1	A8F	A6F	50	160	5.0	100	4.7K	00
MMUN2230LT1	MMUN2130LT1	A8G	A6G	50	3.0	5.0	100	1.0K	1.0K
MMUN2231LT1	MMUN2131LT1	A8H	A6H	50	8.0	5.0	100	2.2K	2.2K
MMUN2232LT1	MMUN2132LT1	A8J	A6J	50	15	5.0	100	4.7K	4.7K
MMUN2233LT1	MMUN2133LT1	A8K	A6K	50	80	5.0	100	4.7K	47K
MMUN2234LT1	MMUN2134LT1	A8L	A6L	50	80	5.0	100	22K	47K
Case 419-02 -	SC-70/SOT-323	243		our L	as		H3	17.754	80710
MUN5211T1	MUN5111T1	8A	6A	50	35	5.0	50	10K	10K
MUN5212T1	MUN5112T1	8B	6B	50	60	5.0	50	22K	22K
MUN5213T1	MUN5113T1	8C	6C	50	80	5.0	50	47K	47K
MUN5214T1	MUN5114T1	8D	6D	50	80	5.0	50	10K	47K
MUN5215T1	MUN5115T1	8E	6E	50	160	5.0	50	10K	00
MUN5216T1	MUN5116T1	8F	6F	50	160	5.0	50	4.7K	00
MUN5230T1	MUN5130T1	8G	6G	50	3.0	5.0	50	1.0K	1.0k
MUN5231T1	MUN5131T1	8H	6H	50	8.0	5.0	50	2.2K	2.2k
MUN5232T1	MUN5132T1	8J	6J	50	15	5.0	50	4.7K	4.78
MUN5233T1	MUN5133T1	8K	6K	50	80	5.0	50	4.7K	47K
MUN5234T1	MUN5134T1	8L	6L	50	80	5.0	50	22K	47K

Table 14. Plastic-Encapsulated Surface Mount Switching Transistors

The following tables are a listing of devices intended for high–speed, low saturation voltage, switching applications. These devices have very fast switching times and low output capacitance for optimized switching performance.

Pinout: 1-Base, 2-Emitter, 3-Collector

		Switching	Time (ns)			hFE@	lc	fT
Device	Marking	ton	toff	V(BR)CEO	Min	Max	mA	MHz Min
Case 318-07 - TO-	236AB (SOT-2	3) — NPN	(615)	n que	3/03	81	dNd	NPN
MMBT2369LT1	M1J	12	18	15	20		100	G-Ost-Fast
MMBT2369ALT1	1JA	12	18	15	20		100	_
BSV52LT1	B2	12	18	12	40	120	10	400
Case 318-07 — TO-	236AB (SOT-2	3) — PNP	68	98	0		NUMBERSTI	THUSSING
MMBT3640LT1	2J	25	35	12	20	_	50	500
Pinout: 1-Emitter, 2 Case 318D-03 — SC	A recover the way to be a constitute	ector					130130000	
MSC1621T1	RB	20	40	20	40	180	1.0	200

Table 15. Plastic-Encapsulated Surface Mount VHF/UHF Amplifiers, Mixers, Oscillators

The following table is a listing of devices intended for small–signal RF amplifier applications to VHF/UHF frequencies. These devices may also be used as VHF/UHF oscillators and mixers.

Pinout: 1-Base, 2-Emitter, 3-Collector

			C _{ch} (13)	f _T @	C
Device	Marking	V(BR)CEO	pF Max	GHz Min	mA
Case 318-07 — TO-	236AB (SOT-23) — NF	PN	Upo(Na)*	A ST WIN TO THE PARTY OF THE PA	E SOLVED
MMBTH10LT1	3EM	25	0.7	0.65	4.0
MMBT918LT1	МЗВ	15	1.7(14)	0.6	4.0
MMBTH24LT1	M3A	30	0.45	(4) (a.e. 0.4 U)	8.0
Case 318-07 — TO-	236AB (SOT-23) — PN	NP .	08	10M 8.0	TTJRS#8TED
MMBTH81LT1	3D	20	0.85	0.6	5.0
MMBTH69LT1	M3J	15	0.35(13)	2.0	10
and the second s	2-Base, 3-Collector	088	08	(er) _{0.5} os	MBTEGBPLTE
Case 318D-03 — SC	CO NIDNI				
Case 316D-03 — 30	,-39 — INFIN				ABMA
MSC2295-BT1	VB VB	20	1.5(13)	0.15	1.0
		20 20	1.5 ⁽¹³⁾ 1.5 ⁽¹³⁾	0.15 0.15	1.0
MSC2295-BT1	VB				
MSC2295-BT1 MSC2295-CT1	VB VC	20	1.5(13)	O.15	1.0
MSC2295-BT1 MSC2295-CT1 MSC2404-CT1	VB VC UC 1S	20 20	1.5(13)	0.15 0.45	1.0
MSC2295-BT1 MSC2295-CT1 MSC2404-CT1 MSC3130T1	VB VC UC 1S	20 20	1.5(13)	0.15 0.45	1.0

⁽¹³⁾ Cre

Table 16. Plastic-Encapsulated Surface Mount Choppers

The following table is a listing of small–signal devices intended for chopper applications where a higher than normal $V_{(BR)CEO}$ is required in the circuit application.

Pinout: 1-Base, 2-Emitter, 3-Collector

	001		21		hFE @ IC	
Device	Marking	V(BR)CEO	V _{(BR)EBO}	Min	Max	mA
ase 318-07 — TO	-236AB (SOT-2	3) — PNP	69	001		17.170583
MMBT404ALT1	2N	35	25	30	400	12

Table 17. Plastic-Encapsulated Surface Mount Darlingtons

The following table is a listing of small–signal devices that have very high hFE and input impedance characteristics. These devices utilize monolithic, cascade transistor construction.

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending her.

00/		VCE(eat)	ps I	TT. PRINTEDIAM	
Marking	V(BR)CES	Volts Max	Min	Max	mA
D-236AB (SOT-2	3) — NPN		23) — PNP	0-235AB (SOT-	Test 318-07-T
as1N	-30	0.1.5	20K	17	100
001M	- 30	001.5	10K	M ac	100
D-236AB (SOT-2	3) — PNP				
2V	30	1.5	20K	_	100
	Marking D-236AB (SOT-2 and 1N and 1M D-236AB (SOT-2	Marking V(BR)CES D-236AB (SOT-23) — NPN	Marking V _{(BR)CES} Volts Max Volts Max Volts Max D-236AB (SOT-23) — NPN S1N	Marking V _{(BR)CES} Volts Max Min D-236AB (SOT-23) — NPN 1 N	Marking V _{(BR)CES} Volts Max Min Max D-236AB (SOT-23) — NPN 1 N

Table 18. Plastic-Encapsulated Surface Mount Low-Noise Transistors

The following table is a listing of small–signal devices intended for low noise applications in the audio range. These devices exhibit good linearity and are candidates for hi–fi and instrumentation equipment.

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of ascending NF.

Arr	ed55 vis	NF	vest the	hFE@ IC			fr
Device	Marking	dB Typ	V(BR)CEO	Min	Max	mA	MHz Min
Case 318-07 — T	O-236AB (SOT	–23) — NPN	70	700	T Market		17.503.603
MMBT5089LT1	1R 84	2.0(15)	25	400	- 864	10	50
MMBT2484LT1	1U	3.0(15)	60	-00	800	10	PT (NON THE
MMBT6428LT1	1KM	3.0	50	250	DATE THE THE	10	100
MMBT6429LT1	1L	3.0	45	500	100	10	100
Case 318-07 — T	O-236AB (SOT	–23) — PNP	(81)38 0	35	LEM		TT.XEBYTTE
MMBT5087LT1	2Q	2.0(15)	50	250	telopiloo-i	10	40

(15) Max

Table 19. Plastic-Encapsulated Surface Mount High-Voltage Transistors

The following table is a listing of small—signal high—voltage devices designed for direct line operation requiring high voltage breakdown and relatively low current capability.

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

	01.0	1000		hFE@ IC		fr
Device	Marking	V(BR)CEO	Min	Max	mA	MHz Min
Case 318-07 — To	D-236AB (SOT-2	3) — NPN				
MMBT6517LT1	1Z	350	15	CHEST REPORTED SOFTING	100	40
MMBTA42LT1	1D	300	40	all-signal_devices in	30	50
MMBT5551LT1	G1	160	30	:gp/lcallor:	50	100
Case 318-07 — To	D-236AB (SOT-2	3) — PNP		10135	eminer, 3-ven	-\$,885th-1 31
MMBT6520LT1	2Z	350	15		100	40
MMBTA92LT1	2D	300	25	OSO(RENV	30	50
MMBT5401LT1	2L	150	50	0.00	50	100

Table 20. Plastic-Encapsulated Surface Mount Drivers

The following is a listing of small—signal devices intended for medium voltage driver applications at fairly high current levels. Pinout: 1–Base, 2–Emitter, 3–Collector

					om esilite me	
Device	Marking	V(BR)CEO	Min	Max	mA	MHz Min
Case 318-07 — T	0-236AB (SOT-	23) — NPN		ending høg.	seeb to tebro r	n netall era seulva
MMBTA06LT1	1GM	80	100		100	100
BSS64LT1	AM	80	20	.eso/i s a/V	10	50
Case 318-07 — T	0-236AB (SOT-	23) — PNP		-23) — NPN	PERSAB (SOT	190 313-07 - TO
BSS63LT1	T1	100	30	08-	25	50
MMBTA56LT1	2GM	80	100	00-	100	50

Table 21. Plastic–Encapsulated Surface Mount General Purpose Amplifiers

Pingut: 1–Base, 2–Collector, 3–Emitter, 4–Collector

	(198)	Vo	hFE@ IC		
Device	Marking	V(BR)CEO	Min	Max	mA
Case 318E-04 — SOT-223 —	NPN		1	SOT-223 — NPI	- 40-8818 see
BCP56T1	BH	80	40	250	150
Case 318E-04 — SOT-223 — Pinout: 1-Gate, 2-Drain, 3-So		1 2 25	1-2-1	SOT-223 — PN	— 60-3818 eas
BCP53T1	AH	80	40	25	150

Table 22. Plastic–Encapsulated Surface Mount Switching Transistors Pinout: 1–Base, 2–Collector, 3–Emitter, 4–Collector

					h	FE	f	Т
Device	Marking	ton	toff	V(BR)CEO	Min	Max	@ I _C (mA)	Min (MHz)
Case 318E-04 — SOT-	223 — NPN							Figure
PZT2222AT1	P1F	35	285	40	100	300	20	300
Case 318E-04 — SOT-	223 — PNP							
PZT2907AT1	P2F	45	100	60	100	300	50	200

Table 23. Plastic–Encapsulated Surface Mount Darlingtons Pinout: 1–Base, 2–Collector, 3–Emitter, 4–Collector

			V _{CE(sat)}	hFE		
Device	Marking	V(BR)CER	Max (V)	Min	Max	@ I _C (mA)
Case 318E-04 — SOT-223 -	– NPN					
BSP52T1 PZTA14T1	AS3 P1N	80 30	1.3 1.5	2000 20k		500 100
Case 318E-04 — SOT-223 -	– PNP					
BSP62T1	BS3	90	1.3	2000	-	500
PZTA64T1	P2V	30	1.5	20k		100

Table 24. Plastic–Encapsulated Surface Mount High–Voltage Transistors Pinout: 1–Base, 2–Collector, 3–Emitter, 4–Collector

			h	hFE fT		Т
Device	Marking	V(BR)CEO	Min	Max	@ I _C (mA)	Min (MHz)
Case 318E-04 — SOT-223 -	- NPN					
BSP19AT1	SP19A	350	40	-	20	70
PZTA42T1	P1D	300	40		10	50
BF720T1	BF720	250	50	_	10	60
BSP20AT1	SP20A	250	40	-	20	70
Case 318E-04 — SOT-223 -	- PNP					
PZTA96T1	ZTA96	450	50	150	10	50
PZTA92T1	P2D	300	40		10	50
BSP16T1	BSP16	300	30	150	10	15
BF721T1	BF721	250	50	_	10	60

Table 25. Plastic–Encapsulated Surface Mount High Current Transistors

Pinout: 1–Base, 2–Collector, 3–Emitter, 4–Collector

				VCE(act)	hFE@ IC		
Device	e keM	Marking	V(BR)CEO	VCE(sat) Volts	Min	Max	mA
Case 318E-04 — S	OT-223 — NI	PN			Man	— 695—700 — a	sá 3185-0
PZT651T1	250	651	60	0.5	75	_	1000
BCP68T1		CA	20	0.5	60	ena krag se	1000
Case 318E-04 — S	OT-223 — Pl	NP			ource, 4-Drift	te, 2-Drein, 3-5	e9-1 dup
PZT751T1	93	ZT751	60	0.5	75	_	1000
BCP69T1		CE	20	0.5	60	_	1000

		niM	
		2000 20k	

Metal-Can Transistors

Metal-can packages are intended for use in industrial applications where harsh environmental conditions are encountered. These packages enhance reliability of the end products due to their resistance to varying humidity and extreme temperature ranges.

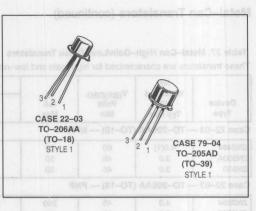


Table 26. Metal-Can General-Purpose Transistors

These transistors are designed for DC to VHF amplifier applications, general–purpose switching applications, and complementary circuitry. Devices are listed in decreasing order of V_{(BR)CEO} within each package group.

	V(BR)CEO	f _T @	Ic	Ic	landard devices	hFE @ IC	dal Buimollol e
Device Type	Volts	MHz Min	mA mA	mA Max	Min	Max	mA
Case 22-03 -	- TO-206AA (TO)-18) — NPN	Volta			Am edio	Device
2N720A	80	50	50	150	40	120	150
2N3700	80	80	50	1000	50	7-07) AA005-0	500
BC107	45	150	10	200	110	450	2.0
BC107A	45	150	10	200	110	220	2.0
BC107B	45	150	10	200	200	450	2.0
2N2222A	40	300	20	800	100	300	150
2N3947	40	300	10	200	100	300	10
BC109C	25	150	10	200	420	800	2.0
Case 22-03 -	-TO-206AA (TO)-18) — PNP	0.35	0.1	40	001 001	19497
2N2906A	60	200	50	600	40	120	150
2N2907A	60	200	50	600	100	300	150
2N3251A	60	300	10	200	100	300	10
BC177B	45	200	10	200	180	460	2.0
Case 79-04 -	- TO-205AD (TO	0–39) — NPN			93/9 (6	E-01) (IAE0S-0'	se 79-04 T
2N3019	80	100	50	1000	100	300	150
2N3020	80	80	50	1000	40	120	150
2N1893	80	50	50	500	40	120	150
2N2219A	40	300	20	800	100	300	150
2N2218A	40	250	20	800	40	120	150
Case 79-04 -	- TO-205AD (TO)-39) — PNP					
2N4033	80		_	1000	25	_	1000
2N4036	65	60	50	1000	40	140	150
2N2904A	60	200	50	600	40	120	150
2N2905A	60	200	50	600	100	300	150
2N4032	60		_	1000	40		1000

Metal-Can Transistors (continued)

Table 27. Metal-Can High-Gain/Low-Noise Transistors

These transistors are characterized for high-gain and low-noise applications. Devices are listed in decreasing order of NF.

	NF	V	111	brid	hFE @ IC		f _T €	∂ IC
Device Type	Wideband dB Typ Max	V(BR)CEO Volts Min	Max	Min	Max	μA mA	MHz Min	mA 9100
Case 22-03	— TO-206AA	(TO-18) — NP	N S-OT					
2N2484	8.0(1)	60	50	100	500	10	15	0.05
2N930A	3.0	45	30	_	600	10	45	0.5
2N930	3.0	45	30	-	600	10	30	0.5
Case 22-03	— TO-206AA	(TO-18) — PN	Р					
2N3964	4.0	45	200	250	600	1.0(24)	50	0.5
2N3799	2.5	60	50	300	900	500	30	0.5

Table 28. Metal-Can High-Voltage/High-Current Transistors

The following table lists Motorola standard devices that have high collector–emitter breakdown voltage. Devices are listed in decreasing order of V(BR)CEO within each package type.

	Vannossa	Ic	nitt hee	@ IC XBM	VCE	(sat) @ Ic &	IB	all f	@ Ic
Device Type	V(BR)CEO Volts Min	mA Max	Min	mA	Volts Max	mA	(81-OT) mA	MHz Min	mA
Case 22-03	- TO-206A	A (TO-18)	— NPN	0001	50	0	В	08	W3700
2N6431 BSS73	300 300	50 500	50 40	30 30	0.5 1.0	20 50	2.0 5.0	50 50	10 20
Case 22-03	- TO-206A	A (TO-18)	— PNP	008	08	00	31	40	N2222A
2N6433 BSS76 2N3497	300 300 120	500 500 100	30 35 40	30 30 10	0.5 0.5 0.35	20 50 10	20 5.0 1.0	50 50 150	10 20 20
Case 79-04	- TO-205A	D (TO-39)	— NPN	000	50	1 00	2	00	Aaoesu
2N4927 2N3500 2N3501	250 150 150	50 300 300	20 40 100	30 150 150	2.0 0.4 0.4	30 150 150	3.0 15 15	30 150 150	10 20 20
Case 79-04	— TO-205A	D (TO-39)	— PNP		-	MAN.	(66-01)	DAGUS-UT	- 10-61 686
2N4931 2N3636 2N3637	250 175 175	50 1000 1000	20 50 100	30 50 50	5.0 0.5 0.5	10 50 50	1.0 5.0 5.0	20 150 200	20 30 30
(1) Typical (24)T _A = 25°C	08		Oh	008	20	08		- 04	NZZ18A

Metal-Can Transistors (continued)

Table 29. Metal-Can Switching Transistors

The following devices are intended for use in general–purpose switching and amplifier applications. Within each package group shown, the devices are listed in order of decreasing turn–on time (t_{on}) .

	1	ton & toff	@ IC	Va	BR)CE	2	Ic	hF	E @ IC	V	CE(sat)	IC @ IB	f_	DETING D
Device Type	ns Max	ns Max	mA	,	Volts Min		mA Max	Min	m.A	Volts	PACIFIC PACE	A m/	MHz	IC mA
Case 22-0	3 — TO-2	206AA (T	O-18) —	NPN									8,	TST leak
2N4014	35	60	500		40	П	1000	35	500	0.52	50	0 50	300	50
2N2369A	12	18	10		15		200	40	10	0.2	1 10	1.0	500	10
BSX20	7.0	21	100	anoil	15	1 88	500	20	10	0.25	10	1.0	500	10
Case 22-0	3 — TO-2	206AA (T	O-18) —	PNP	Jiner	nqi	non equ	Inemu	iteni boi	(or hi-fi	etabib)	nd are on	ns yinsenii t	roop lidin
2N3546	40	30	50	04	12	-	200	25	50	0.25	50	5.0	700	10
Case 79-0	4 — TO-2	205AD (T	O-39) —	NPN	Ott	O(F	8)V ;	Cra	23:0	-				
MM3725	35	60	500	edito:	40	nin	2000	35	500	0.52	50	0 50	300	50
Case 79-0	4 — TO-2	205AD (T	O-39) —	PNP					16	V-Chann	- (50-	OT) AAS	155-01 1	0-85 but
2N3467	40	90	500	1.0	40	00	1000	40	500	100	50		100	50
2N3468	40	90	500	101	50	89	1000	25	500	0.6	50	0 50	150	50
				2.0										

| Part |

Field-Effect Transistors

JFETs

JFETs operate in the depletion mode. They are available in both P– and N–channel and are offered in both Through–hole and Surface Mount packages. Applications include general–purpose amplifiers, switches and choppers, and RF amplifiers and mixers. These devices are economical and very rugged. The drain and source are interchangeable on many typical FETs.

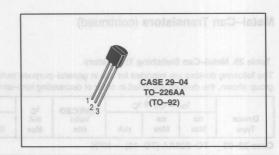


Table 1. JFET Low-Frequency/Low-Noise

The following table is a listing of small–signal JFETs intended for low–noise applications in the audio range. These devices exhibit good linearity and are candidates for hi–fi and instrumentation equipment.

01	R _e Y _{fs}	@ f	R _e Y _o	s @ f	C _{iss}	C _{rss}	V(BR)GSS V(BR)GDO		(off)		SS A	V3546
Device	mmho Min	kHz	μmho Max	kHz	pF Max	pF Max	Volts Min	Min	Max	Min	Max	Style
Case 29-04	— TO-22	6AA (TO	92) — N	l-Chanr	nel			949-	- (ac-or	0 A201	4-70	ise 79-0
J202	851	ia	0090	0 1	666	3b(40	0.8	4.0	0.9	4.5	5
2N5458	1.5	1.0	50	1.0	7.0	3.0	25	1.0	7.0	2.0	9.0	5
J203	_	_	-	_	-	_	40	2.0	10	4.0	20	5
MPF3821	1.5	1.0	10	1.0	6.0	3.0	50	-	4.0	0.5	2.5	5
2N5457	1.0	1.0	50	1.0	7.0	3.0	25	0.5	6.0	1.0	5.0	5
2N5459	2.0	1.0	50	1.0	7.0	3.0	25	2.0	8.0	4.0	16	5
MPF3822	3.0	1.0	20	1.0	6.0	3.0	50	_	6.0	2.0	10	5
Case 29-04	— TO-22	6AA (TC)-92) — F	-Chanr	nel							
2N5460	1.0	1.0	75	1.0	7.0	2.0	40	0.75	6.0	1.0	5.0	7
2N5461	1.5	1.0	75	1.0	7.0	2.0	40	1.0	7.5	2.0	9.0	7
2N5462	2.0	1.0	75	1.0	7.0	2.0	40	1.8	9.0	4.0	16	7

Table 2. JFET High-Frequency Amplifiers

The following is a listing of small–signal JFETs that are intended for hi–frequency applications. These are candidates for VHF/UHF oscillators, mixers and front–end amplifiers.

	Re Yf	s @ f	R _e Y _o	s @ f	C _{iss}	C _{rss}	NF @ R	G = 1K	V(BR)GSS V(BR)GDO	V _G	S(off) olts		SS nA	
Device	mmho Min	MHz	μ mho Max	MHz	pF Max	pF Max	dB Max	f MHz	Volts Min	Min	Max	Min	Max	Style
Case 29-	-04 — T	D-226A	A (TO-9	2) — N-	Channe	i								
2N5669	1.6	100	100	100	7.0	3.0	2.5	100	25	1.0	6.0	4.0	10	5
MPF102	1.6	100	200	100	7.0	3.0	_	-	25	_	8.0	2.0	20	5
2N5668	1.0	100	50	100	7.0	3.0	2.5	100	25	0.2	4.0	1.0	5.0	5
2N5484	2.5	100	75	100	5.0	1.0	3.0	100	25	0.3	3.0	1.0	5.0	5
2N5670	2.5	100	150	100	7.0	3.0	2.5	100	25	2.0	8.0	8.0	20	5
2N5485	3.0	400	100	400	5.0	1.0	4.0	400	25	0.5	4.0	4.0	10	5
2N5486	3.5	400	100	400	5.0	1.0	4.0	400	25	2.0	6.0	8.0	20	5
J300	4.5	0.001	200	0.001	5.5	1.7	_	_	25	1.0	6.0	6.0	30	5
J308	12(1)	100	250(1)	100	7.5	2.5	1.5(1)	100	25	1.0	6.5	12	60	5
J309	12(1)	100	250(1)	100	7.5	2.5	1.5(1)	100	25	1.0	4.0	12	30	5
J310	12(1)	100	250(1)	100	7.5	2.5	1.5(1)	100	25	2.0	6.5	24	60	5

(1)Typical

Table 3. JFET Switches and Choppers

The following is a listing of JFETs intended for switching and chopper applications.

	R _{DS} (on) @ ID		S(off) olts		SS A	V(BR)GSS V(BR)GDO	C _{iss}	C _{rss}	ton	toff	
Device	Ω Max	mA	Min	Max	Min	Max	Volts Min	pF Max	pF Max	ns Max	ns Max	Style
Case 29-0	4 — TO-2	26AA (TC)-92) — I	N-Channe	el /							
MPF4856	25	_	4.0	10	50	TP	40	18	8.0	9.0	25	5
MPF4859	25	_	4.0	10	50	445	30	18	8.0	9.0	25	5
J111	30	_	3.0	10	20		35	28	5.0	_		5
MPF4857	40	_	2.0	6.0	20	100	40	18	8.0	10	50	5
MPF4860	40	_	2.0	6.0	20	100	30	18	8.0	10	50	5
J112	50	_	1.0	5.0	5.0		35	28	5.0	_	_	5
MPF4392	60		_	-	25	75	30	10	3.5	15	35	5
2N5639	60	1.0	_	(8.0)(1)	25	_	30	10	4.0	_	_	5
MPF4858	60	_	0.8	4.0	8.0	80	40	18	8.0	20	100	5
MPF4861	60		0.8	4.0	8.0	80	30	18	8.0	20	100	5
MPF4393	100	_	0.0	(12)(1)	5.0	30	30	10	3.5	15	55	5
2N5640	100	1.0	orto bas r	(6.0)(1)	5.0	30	30	10	4.0	18	45	5
J113	100	1.0	0.5	3.0	2.0		35	28	5.0	no le de	45	5
2N5555	150		0.5	1.0(16)	15		25	5.0	1.2	10	25	5
BF246A	35(1)	1.0	0.6	14	30	80	25	5.0		10	25	22
BF246B	50(1)	1.0	0.6	14	60	140	25		G 0 (n	NegA .		22
DFZ40D		1.0	0.0	14	00	140	25		-	-	1	
J110	18	87-	0.5	4.0	10	- Vic	25	_	-		-	5
J110 Case 29–0						9V —	25	100	- - -	ABIN	63	5
Case 29-0 MPF970			5.0	P-Channe	15	100	30	12	5.0	8.0	25	5
Case 29–0 MPF970 MPF971	4 — TO-2 100 250	1.0 1.0	5.0 1.0	7.0	15 2.0	50	30 30	12	5.0	10	120	5 5
MPF970 MPF971	4 — TO-2 100 250	1.0 1.0	5.0 1.0	P-Channe 12 7.0	15 2.0	50	30 30	12	5.0	10	120	5 5
MPF970 MPF971 (1)Typical (16)V _{GS} (f)	4 — TO-2 100 250	1.0 1.0	5.0 1.0	7.0	15 2.0	50	30 30	12	5.0	10	120	5 5
MPF970 MPF971 (1)Typical (16)VGS(f)	4 — TO-2 100 250	1.0 1.0	5.0 1.0	7.0	15 2.0	50	30 30	12	5.0	10 0.8 0.8	120	5 5
MPF970 MPF971 (1)Typical (16)VGS(f)	4 — TO-2 100 250	1.0 1.0	5.0 1.0	7.0	15 2.0	50	30 30	12	5.0	10	120	5 5
MPF970 MPF971 MPF971 (1)Typical (16)VGS(f)	4 — TO-2 100 250	1.0 1.0	5.0 1.0	12 7.0	15 2.0	50	30 30	12	5.0	10 8.1 0.8 0.8 0.8	120	5 5
MPF970 MPF971 (1)Typical (16)VGS(f)	4 — TO-2 100 250	1.0 1.0	5.0 1.0	7.0	15 2.0	50	30 30	12	5.0	10	120	5 5
Case 29–0 MPF970 MPF971 (1)Typical (16)V _{GS(f)}	4 — TO-2 100 250	1.0 1.0	5.0 1.0	P-Channe 12 7.0	15 2.0	50	30 30	12	5.0	10 0.8 0.8 0.8 0.8 0.8	120	5 5
Case 29–0 MPF970 MPF971 (1)Typical (16)V _{GS} (f)	4 — TO-2 100 250	1.0 1.0 1.0	5.0 1.0	P-Channe 12 7.0	15 2.0	50	30 30 30	12	0.5.0 0.1 0.1 0.1 0.0 2.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3	10 8 r 0 s 0 s 0 s 0 s 0 s	120	5 5
Case 29–0 MPF970 MPF971 (1)Typical (16)V _{GS} (f)	4 — TO-2 100 250	1.0 1.0 1.0	5.0 1.0	P-Channe 12 7.0	15 2.0	50	30 30 30	12	5.0 0.1 0.1 0.1 0.0 2.0 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0	10 0.8 0.8 0.8 0.8 0.8	120	5 5
Case 29–0 MPF970 MPF971 (1)Typical (16)V _{GS} (f)	4 — TO-2 100 250	1.0 1.0 1.0	0-92) — I 5.0 1.0 (f) 6 (f) 8	P-Channe 12 7.0	15 2.0	50	30 30 30 30 30 30 30 30 30 30	12	0.5.0 0.1 0.1 0.1 0.0 2.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3	10 8 r 0 s 0 s 0 s 0 s 0 s	120	5 5
Case 29–0 MPF970 MPF971 (1)Typical (16)V _{GS} (f)	4 — TO-2 100 250	1.0 1.0 1.0	5.0 1.0 (1)4 (1)4 (1)4 (1)4 (1)5 0.8	P-Channe 12 7.0	15 2.0	50	30 30 30	12	5.0 0.1 0.1 0.1 0.0 2.0 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0	10 8 r 0 s 0 a 0 a 0 a 0 a 0 a 0 a	120	5 5
Case 29–0 MPF970 MPF971 (1)Typical (16)VGS(f)	4 — TO-2 100 250	1.0 1.0 1.0	5.0 1.0 (7)4 (7)5 (7)5 (7)5 (7)5 (7)5 (7)5 (7)5 (7)5	P-Channe 12 7.0	15 2.0	50	30 30 30 30 30 30 45 45 45 45 45 45 45 45 45 45 45 45 45	12	0.1 0.1 0.1 0.0 2.0 2.0 2.0 2.0	10 6 f 0.8 0.8 0.8 0.8 0.8 0.8 0.8	120	5 5
Case 29–0 MPF970 MPF971 (1)Typical (16)VGS(f)	4 — TO-2 100 250 08 81 08 08 08	1.0 1.0 1.0 2.2 2.3 2.3 2.3 2.3 2.3 2.3 2.3 2.3 2.3	5.0 1.0 (7)8 (7)8 (7)8 (7)8 (7)8 (7)8 (7)8 (7)8	P-Channe 12 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0	15 2.0	50	30 30 30 08 08 08 08 08 08 08 08 08 08 08 08 08	12 0 1.1 0 0 0 0 1.0 0 0 1.0 0 1.0 0 1.0 0 1.0 0 0 0	0.1 0.7 0.7 0.1 0.0 2.0 2.0 2.0 0.1 6.0 5.0 6.0 5.0	10 8 f 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8	120	5 5
Case 29–0 MPF970 MPF971 (1)Typical (116)VGS(f)	4 — TO-2 100 250	1.0 1.0 1.0	0-92) — I 5.0 1.0 (f) 6	P-Channe 12 7.0	15 2.0	50	30 30 30 0.8 8.8 0.9 4.8 8.8 0.8 8.8 0.8 8.8 8.8 8.8 8.8 8.8 8	112 1.0 1.1 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	10 81 08 08 08 08 08 08 08 08 08 08 08 08	120	5 5
Case 29–0 MPF970 MPF971 (1)Typical (16)VGS(f)	4 — TO-2 100 250 08 81 08 08 08	1.0 1.0 1.0 2.2 2.3 2.3 2.3 2.3 2.3 2.3 2.3 2.3 2.3	5.0 1.0 (7)8 (7)8 (7)8 (7)8 (7)8 (7)8 (7)8 (7)8	P-Channe 12 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0	15 2.0	50	30 30 30 08 08 08 08 08 08 08 08 08 08 08 08 08	112 1.0 1.1 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	10 8 r 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8	120	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
Case 29–0 MPF970 MPF971 (1)Typical (16)VGS(f)	4 — TO-2 100 250	26AA (TO 1.0 1.0 1.0 2.2 2.2 3.3 3.3 3.3 3.3 3.3 3.3 3.3 3.3	0-92) — I 5.0 1.0 (f) 6	P-Channe 12 7.0 100 (1)00 (1	15 2.0	50	30 30 30 30 30 30 30 45 45 45 45 45 45 45 45 45 45 45 45 45	12 3.0 3.1 3.0 3.0 3.0 4.0 4.0 4.0	0.5.0 0.1 0.1 0.1 0.1 0.0 0.0 0.0 0.0 0.0 0	10 8 r 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8	120	5 5 5
Case 29–0 MPF970 MPF971 (1)Typical (16)V _{GS} (f)	4 — TO-2 100 250 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8	26AA (TO 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	D-92) — I 5.0 1.0 (1)a (1)a (1)a (1)a (1)a (1)a (1)a (1)a	P-Channe 12 7.0	15 2.0	50	30 30 30 30 30 30 30 48 48 48 48 48 48 48 48 48 48 48 48 48	12	0.5.0 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0	10 8 f 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8	120	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
Case 29–0 MPF970 MPF971 (1)Typical (16)VGS(f)	4 — TO-2 100 250 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.	1.0 1.0 1.0 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0	D-92) — I 5.0 1.0 (1)	P-Channe 12 7.0	15 2.0	50	30 30 30 30 30 30 30 30 30 45 45 45 45 45 45 45 45 45 45 45 45 45	7 12	0.5.0 0.1 0.1 0.1 0.1 0.1 0.0 0.0 0.1 0.0 0.0	10 8 f 0 S 0 8 0 A 0 A 0 A 0 A 0 A 0 A 0 A 0 A 0 A 0 A	120	5 5



TMOS FETs

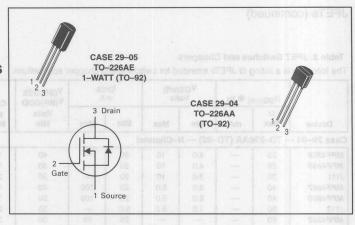


Table 4. TMOS Switches and Choppers

The following is a listing of small–signal TMOS devices that are intended for switching and chopper applications. These devices offer low R_{DS(on)} characteristics.

	R _{DS(o}	n) @ ID	VG	S(th)	V _{(BR)DSS}	Ciss	C _{rss}	ton	toff	AP246A
Device	Ω Max	А	Min	Max	Volts Min	pF Max	pF Max	ns Max	ns Max	Style
Case 29-05 —	TO-226AE	(1-WATT	TO-92) -	- N-Chann	el					
MPF930	1.4	1.0	1.0	3.5	35	70(1)	20(1)	15	15	22
MPF960	1.7	1.0	1.0	3.5	60	70(1)	20(1)	15	15	22
MPF6659	1.8	1.0	0.8	2.0	35	30(1)	4(1)	5.0	5.0	22
MPF990	2.0	1.0	1.0	3.5	90	70(1)	20(1)	15	15	22
MPF6660	3.0	1.0	0.8	2.0	60	30(1)	4(1)	5.0	5.0	22
MPF6661	4.0	1.0	0.8	2.0	90	30(1)	4(1)	5.0	5.0	22
MPF910	5.0	0.5	0.3	2.5	60	_	_	_		22
VN10LM	5.0	0.5	0.8	2.5	60	60	5.0	10	10	22
Case 29-04 —	TO-226AA	(TO-92)	— N-Char	nnel						
VN0300L	1.2	1.0	0.8	2.5	60	100	25	30	30	22
2N7000	5.0	0.5	0.8	3.0	60	60	5.0	10	10	22
BS170	5.0	0.2	0.8	3.0	60	25(1)	3.0(1)	10	10	30
VN0610LL	5.0	0.5	0.8	2.5	60	60	5.0	10	10	22
VN1706L	6.0	0.5	0.8	2.0	170	125	20	8.0	18	22
VN2406L	6.0	0.5	0.8	2.0	240	125	20	8.0	23	22
BSS89	6.0	0.30	1.0	2.7	200	72(1)	3.0(1)	6.0(1)	12(1)	7
BS107A	6.4	0.25	1.0	3.0	200	60(1)	6.0(1)	15	15	30
2N7008	7.5	0.5	1.0	2.5	60	50	5.0	20	20	22
VN2222LL	7.5	0.5	0.6	2.5	60	60	5.0	10	10	22
VN2410L	10	0.5	0.8	2.0	240	125	20	8.0	23	22
BS107	14	0.2	1.0	3.0	200	60(1)	6.0(1)	15	15	30

(1)Typical

Surface Mount FETs

This section contains the FET plastic packages available for surface mount applications. Most of these devices are the most popular metal-can and insertion type parts carried over to the new surface mount packages.



CASE 318-07 TO-236AB SOT-23



CASE 318E-04 SOT-223

Table 5. Surface Mount RF JFETs

The following is a list of surface mount FETs which are intended for VHF/UHF RF amplifier applications. Pinout: 1-Drain, 2-Source, 3-Gate

	9.8	N	IF .	100	Yfs @ VDS			
Device	Marking	dB Typ	f MHz	mmhos Min	mmhos Max	Volts	V _{(BR)GSS}	Style
Case 318-07 — TO-	236AB (SOT-	-23) — N-C	hannel	30	25	T. N	/8 17.	185711,7481
MMBFJ309LT1	6U	1.5	450	10	20	10	25	10
MMBFJ310LT1	6T	1.5	450	8.0	18	10	25	10
MMBFU310LT1	M6C	1.5	450	10	18	10	25	10
MMBF4416LT1	M6A	2(3)	100	4.5	7.5	15	30	10
MMBF5484LT1	M6B	2.0	100	3.0	6.0	15	25	10
MMBF5486LT1	6H	2.0	100	4.0	8.0	15	25	10

(3)_{Max}

Table 6. Surface Mount General-Purpose JFETs

The following table is a listing of surface mount small-signal general purpose FETs. These devices are intended for small-signal amplification for DC, audio, and lower RF frequencies. They also have applications as oscillators and general-purpose, low-voltage switches. Pinout: 1-Drain, 2-Source, 3-Gate

				Yfs @ VDS	mienti	I _D	SS	0-1 Hrp
Device	Marking	V _(BR) GSS	mmhos Min	mmhos Max	Volts	mA Min	mA Max	Style
Case 318-07 - TO	D-236AB (SO	T-23) — N-Ch	nannel	and A	in and	politic	M	SpivioC
MMBF5457LT1	6D	25	1.0	5.0	15	1.0	5.0	10
MMBF5459LT1	6L	25	2.0	6.0	15	4.0	16	10
Case 318-07 — TO	D-236AB (SO	T-23) — P-Ch	annel	08 00	0.4	1000		NET SERVING
MMBF5460LT1	M6E	40	1.0	4.0	15	1.0	5.0	10

Surface Mount FETs (continued)

Table 7. Surface Mount Choppers/Switches JFETs

The following is a listing of small–signal surface mount JFET devices intended for switching and chopper applications.

Pinout: 1-Drain, 2-Source, 3-Gate

	1 20 000	R _{DS(on)}	toff		VGS	G(off)	ID	SS	
Device	Marking	Ohms Max	ns Max	V _(BR) GSS	Volts Min	Volts Max	mA Min	mA Max	Style
Case 318-07 — TO	D-236AB (SO	Г–23) — N–0	Channel						TIME
MMBF4856LT1	AAA	25	25	40	-4.0	-10	50	BOIS BOST	10
MMBF4391LT1	6J	30	20	30	-4.0	-10	50	150	10
MMBF4860LT1	6F	40	50	30	-2.0	-6.0	20	100	10
MMBF4392LT1	6K	60	35	30	-2.0	-5.0	25	75	10
MMBF4393LT1	6G	100	50	30	-0.5	-3.0	5.0	30	10
Case 318-07 — TO	D-236AB (SO	Г–23) — Р–С	Channel	Miles	skille.	q/l	palaheld	ac ac	Devic
MMBFJ175LT1	6W	125		30	3.0	6.0	7.0	60	10
MMBFJ177LT1	6Y	300	-	30	0.8	2.5	1.5	20	10

Table 8. TMOS FETs

The following is a listing of small—signal surface mount TMOS FETs which exhibit low $R_{DS(on)}$ characteristics. Pinout: 1–Gate, 2–Source, 3–Drain

		RDS(or	n) @ ID		VGS	S(th)	Switchi	ng Time	
Device	Marking	Ohm	mA	V _{DSS}	Volts Min	Volts Max	t _{on} ns	t _{off} ns	Style
2 210 07 T	0 00040 (007	00) N (011						
Case 318–07 — T	0-236AB (SOI-	-23) — N-C	Channel	grang general	le-lleme in	mulice mon	i lighing of sa	ng kabis is s	ivollow
MMBF170LT1	6Z	5.0	200	60	0.8	3.0	10	10	21
(at a position		To be deler	1.0000000000000000000000000000000000000	60	0.8	3.0 2.8	10 20	10 40	21 21

Pinout: 1-Gate, 2-Drain, 3-Source, 4-Drain

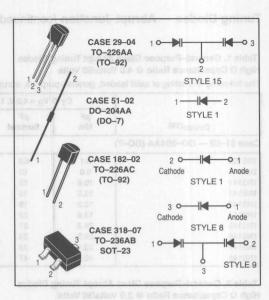
	an Am	R _{DS} (on)		offrites	V _{GS(th)}		Switching Time		
Device	Marking	Ohm	mA	V _{DSS}	Volts Min	Volts Max	t _{on} ns	t _{off} ns	Style
Case 318E-04 S	OT-223 — N-0	Channel		5.0	0.1	32	G9	1 11	CONSTRUCTION .
MMFT960T1	FT960	1.7	1000	60	1.0	3.5	15	15	3
MMFT960T1 MMFT6661T1	FT960 T6661	1.7 4.0	1000 1000	60 90	1.0	3.5 2.0	15 5.0	15 5.0	3 3
					Best of the same of	L 437 LLL 2 (5 (0) LL		Barrier TO	3 3 3

Tuning and Switching Diodes Tuning Diodes — Abrupt Junction

Motorola supplies voltage—variable capacitance diodes serving the entire range of frequencies from HF through UHF. Used in RF receivers and transmitters, they have a variety of applications, including:

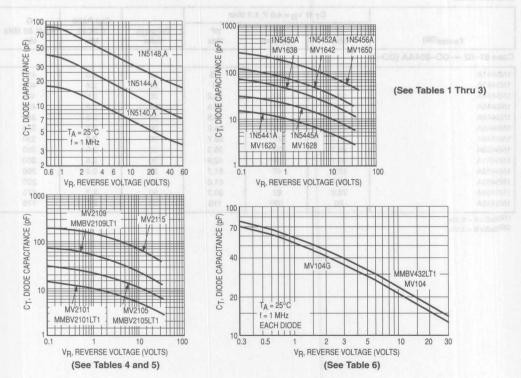
- Phase-locked loop tuning systems
- · Local oscillator tuning
- Tuned RF preselectors
- RF filters
- RF phase shifters
- RF amplifiers
- Automatic frequency control
- · Video filters and delay lines
- Harmonic generators
- FM modulators

Two families of devices are available: Abrupt Junction and Hyper Abrupt Junction. The Abrupt Junction family includes devices suitable for virtually all tuned—circuit and narrow—range tuning applications throughout the spectrum.



Typical Characteristics

Diode Capacitance versus Reverse Voltage



Tuning Diodes — Abrupt Junction (continued)

Table 1. General-Purpose Glass Abrupt Tuning Diodes High Q Capacitance Ratio @ 4.0 Volts/60 Volts

The following is a listing of axial leaded, general-purpose, abrupt tuning diodes. These devices exhibit high Q characteristics.

	CASE S -O2	@ V _R = 4.0 V, 1.0	MHz	tainer a avari-	Cap Ratio	Q	
Device(19)	pF Min	pF Nominal	pF Max	V(BR)R Volts	C4/C60 Min	4.0 V, 50 MHz Min	
Case 51-02 — DO-204AA	(DO-7)				tuning	Local oscillator	
1N5139	6.1	6.8	7.5	60	2.7	350	
1N5140	9.0	10	11	60	2.8	300	
1N5141	10.8	12	13.2	60	2.8	300	
1N5142	13.5	15	16.5	60	2.8	250	
1N5143	16.2	18	19.8	60	2.8	250	
1N5144	19.8	22	24.2	60	3.2	200	
1N5145	24.3	27	29.7	60	3.2	200	
1N5146	29.7	33	36.3	60	3.2	200	
1N5147	35.1	39	42.9	60	3.2	200	
1N5148	42.3	47	51.7	60	3.2	200	

Table 2. General-Purpose Glass Abrupt Tuning Diodes High Q Capacitance Ratio @ 2.0 Volts/30 Volts

The following is a listing of axial leaded, general–purpose, abrupt tuning diodes. These devices exhibit very high Q characteristics.

	CT	@ V _R = 4.0 V, 1.0	MHz		Cap Ratio	Q	
Device(20)	pF Min			VR(BR)R Volts	C2/C30 Min	4.0 V, 50 MHz Min	
Case 51-02 — DO-204AA (DO	0-7)			T ASHBIII 支		# 1	
1N5441A	6.1	6.8	7.5	30	2.5	450	
1N5443A	9.0	10	11	30	2.6	400	
1N5444A	10.8	12	13.2	30	2.6	400	
1N5445A	13.5	15	16.5	30	2.6	400	
1N5446A	16.2	18	19.8	30	2.6	350	
1N5448A	19.8	22	24.2	30	2.6	350	
1N5449A	24.3	27	29.7	30	2.6	350	
1N5450A	29.7	33	36.3	30	2.6	350	
1N5451A	35.1	39	42.9	30	2.6	300	
1N5452A	42.3	47	51.7	30	2.6	250	
1N5453A	50.4	56	61.6	30	2.6	200	
1N5455A	73.8	82	90.2	30	2.7	175	
1N5456A	90	100	110	30	2.7	175	

(19)Suffix A = 5.0% (20)Suffix B = 5.0%

Tuning Diodes — Abrupt Junction (continued) and and another June Abrupt June A

Table 3. General-Purpose Glass Abrupt Tuning Diodes Capacitance Ratio @ 2.0 Volts/20 Volts

The following is a listing of axial leaded, general-purpose, abrupt tuning diodes. These devices exhibit high Q characteristics.

SHM 08 V 0. Device		C _T @ V _R = 4.0 V, 1.0 MHz								Cap Ratio	Q
		R(AS)A	pF pF Nominal		pF Max		V _{(BR)R} Volts		C2/C20 Min	4.0 V, 50 MHz Typ	
Case 51-02 -	- DO-204AA (DO)-7)		Model		ndymen	091	Rills	00 200	1017	eù.
MV1620			6.1		6.8		7.5		20	2.0	300
MV1624		30	9.0	7.5	10	8.8	11	1.8	20	2.0	300
MV1626		30	10.8	21	12	10	13.2	0.0	20	2.0	300
MV1628		3.0	13.5	13.2	15	24	16.5	8.01	20	2.0	250
MV1630		30	16.2	18.5	18	ar	19.8	13.6	20	2.0	250
MV1634		30	19.8	24.2	22	22	24.2	3.87	20	2.0	250
MV1636		30	24.3	29.7	27	27	29.7	24,3	20	2.0	200
MV1638		06	29.7	E.88	33	33	36.3	7.03	20	2.0	200
MV1640			35.1	1	39		42.9		20	2.0	200
MV1642			42.3		47		51.7	ollwei i	20	2.0	200
MV1644			50.4	V 1	56		61.6	No. of Contract of	20	2.0	150
MV1648		KUIGO OIDIR	73.8	SIT 12 1252	82	SI SIVE	90.2	2000	20	2.0	150
MV1650			90		100		110	(22)	20	2.0	150

Table 4. General-Purpose Plastic Abrupt Tuning Diodes Capacitance Ratio @ 2.0 Volts/30 Volts

The following is a listing of plastic package, general–purpose, abrupt tuning diodes. These devices exhibit high Q characteristics.

	CT	@ V _R = 4.0 V, 1.0 I	MHz	SOT-23}	Cap Ratio	Q	
Device	pF Min	bi bi		V _R (BR)R Volts	C4/C30 Min	4.0 V, 50 MH Typ	
Case 182-02 — TO-226AC (1	O-92) — 2-Lead					22) Each Dioda	
MV2101	6.1	6.8	7.5	30	2.5	400	
MV2103	9.0	10	11	30	2.5	350	
MV2104	10.8	12	13.2	30	2.5	350	
MV2105	13.5	15	16.5	30	2.5	350	
MV2107	19.8	22	24.2	30	2.5	300	
MV2108	24.3	27	29.7	30	2.5	250	
MV2109	29.7	33	36.3	30	2.5	200	
MV2111	42.3	47	51.7	30	2.5	150	
MV2113	61.2	68	74.8	30	2.5	150	
MV2114	73.8	82	90.2	30	2.5	100	
MV2115	90	100	110	30	2.6	100	

Tuning Diodes — Abrupt Junction (continued) and any molecular approach — ashold points

Table 5. Surface Mount Abrupt Tuning Diodes Capacitance Ratio @ 2.0 Volts/30 Volts

The following is a listing of surface mount abrupt junction tuning diodes intended for general–purpose variable capacitance circuit applications.

			CT	@ V _R = 4.0 V, 1.	0 MHz	34	Cap Ratio	0
Dev		atto	pF Min	pF Nominal	pF Max	V _R (BR)R Volts	C2/C30 Min	4.0 V, 50 MHz Typ
Case 318-07 — D	00-236AB (S	OT-23)			0.0			ACTION IN
MMBV2101LT1	0.5	OS:	6.1	6.8	7.5	30	2.5	400
MMBV2103LT1		085	9.0	10	St 11	30	2.5	350
MMBV2104LT1		08	10.8	12	13.2	30	2.5	350
MMBV2105LT1		00	13.5	15	16.5	30	2.5	350
MMBV2107LT1		20	19.8	22	24.2	30	2.5	300
MMBV2108LT1		20	24.3	27	29.7	30	2.5	250
MMBV2109LT1		20	29.7	33	36.3	30	2.5	200

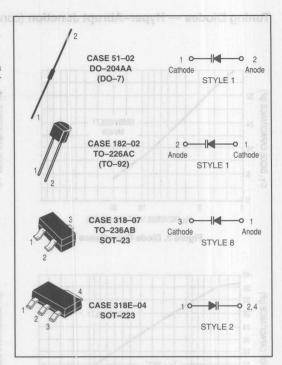
Table 6. Abrupt Tuning Diodes for FM Radio — Dual

The following is a listing of abrupt tuning diodes that are available as dual units in a single package.

	0.8	CT @ VR(22)	011	Cap Ratio	0				
Device	pF Min	pF Max	Volts	C3/C30 Min	3.0 V, 50 MHz Min	V _{(BR)R} Volts	Device Marking	Style	
Case 29-04 — TO-	-226AA (TO-	-92)	leather region d	tra sala anam	on Inches No.	OV UELENOV	U.S. SP OHIGH S	apacitance	
MV104	37	42	3.0	2.5	100	32	- 10	15	
Case 318-07 — TO	D-236AB (SC	T-23)		+4.0 V, 1.0.ETH	gV 0 10				
MMBV432LT1	43	48.1	2.0	1.5(21)	100	14	M4B	9	
(21)C2/C8 (22)Each Diode	FIRST	EUROV	2,546	ungano		- (\$e-0T) D	2 TO-225A	0-687 988	

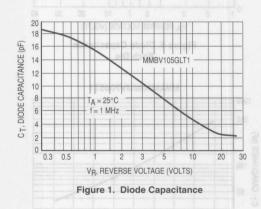
Tuning Diodes — Hyper–Abrupt Junction

The Hyper–Abrupt family exhibits higher capacitance, and a much larger capacitance ratio. It is particularly well suited for wider–range applications such as AM/FM radio and TV tuning.



Typical Characteristics

Diode Capacitance versus Reverse Voltage



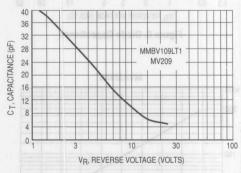


Figure 2. Diode Capacitance

Tuning Diodes — Hyper-Abrupt Junction (continued)

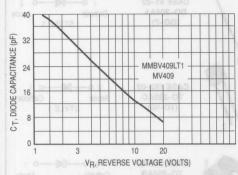


Figure 3. Diode Capacitance

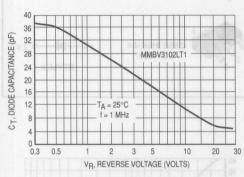


Figure 5. Diode Capacitance

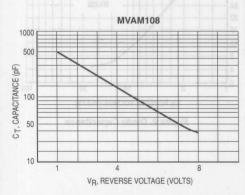


Figure 7. Capacitance versus Reverse Voltage

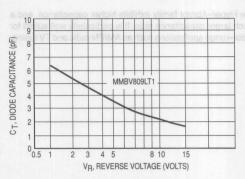


Figure 4. Diode Capacitance

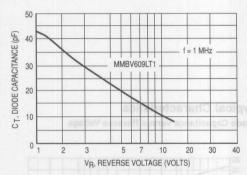


Figure 6. Diode Capacitance Each Die

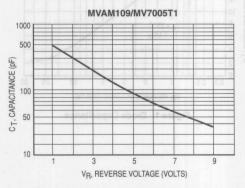
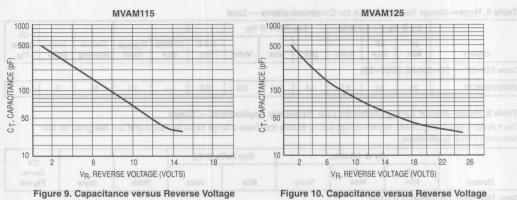


Figure 8. Capacitance versus Reverse Voltage



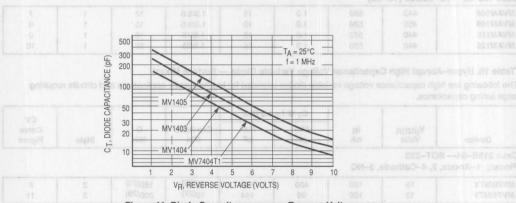


Figure 11. Diode Capacitance versus Reverse Voltage

Table 7. Hyper-Abrupt Tuning Diodes for Telecommunications — Single

The following is a listing of hyper-abrupt tuning diodes intended for high frequency, FM radio, and TV tuner applications.

	C _T @	V_R (f = 1.	0 MHz)	Ca	Ratio @	VR		Q	- 0.00			1 - C 1 - C
Device	pF Min	pF Max	Volts	Min	Max	Volts	3.0 V Min	50 MHz Max	V _{(BR)R} Volts	Device Marking	Case Style	
Case 182-02 — TO)-226AC (TO-92)	00		01		2.0	906	0	02		AV140S
MV209	26	32	3.0	5.0	6.5	3/25	200	_	30	Voc	1	2
MV409	26	32	3.0	1.5	2.0	3/8	200	-	20	- VDI =	100	3
Case 318-07 — TO	D-236AB (SOT-23)					EW II		1.0 MHz	al Vos	AV (es
MMBV105GLT1	1.5	2.8	25	4.0	6.5	3/25	200	_	30	M4E	8	1
MMBV109LT1	26	32	3.0	5.0	6.5	3/25	200		30	M4A	8	2
MMBV409LT1	26	32	3.0	1.5	1.9	3/8	200	_	20	X5	8	3
MMBV809LT1	4.5	6.1	2.0	1.8	2.6	2/8	300	_	20	5K	8	4
MMBV3102LT1	20	25	3.0	4.5	_	3/25	200	_	30	M4C	8	5

Tuning Diodes — Hyper-Abrupt Junction (continued) 11. [gundA-19gyM — abboild pninuT

Table 8. Hyper-Abrupt Tuning Diodes for Communications — Dual

	CT @	C _T @ V _R (f = 1.0 MHz)		Cap	Ratio @	VR		Q				cv
Device	pF Min	pF Max	Volts	Min	Max	Volts	3.0 V Min	50 MHz Max	V _{(BR)R} Volts	Device Marking	Case Style	Curve
Case 318-07 - T	O-236AB (SOT-23	3)	1	- 6							
MMBV609LT1	26	32	3.0	1.8	2.4	3/8	250	_	20	5L	9	6

Table 9. Hyper-Abrupt Tuning Diodes for Low Frequency Applications — Single

The following is a listing of AM, hyper–abrupt tuning diodes that have a large capacity range and are designed for low frequency circuit applications.

		CT @ 1.0 MHz	2 0 0	Cap Ra	tio @ VR	(1)	a	CV Curve Figure
Device	pF Min	pF Max	Volts	Min	Volts	V(BR)R Volts	Style	
Case 182-02- TO	D-226AC (TO-	-92)	D.D. STUDIT	95	ражи ветаул	H BUSTEV 901	e, capacitat	ambi-i
MVAM108	440	560	1.0	15	1.0/8.0	12	1	7
MVAM109	400	520	1.0	12	1.0/9.0	15	1	8
MVAM115	440	560	1.0	15	1.0/15	18	1	9
MVAM125	440	560	1.0	15	1.0/25	28	1	10

Table 10. Hyper-Abrupt High Capacitance Voltage Variable Diode — Surface Mount

The following are high capacitance voltage variable diodes intended for low frequency applications and circuits requiring large tuning capacitance.

			C _T @ f = 1.0 MHz		A North		9	cv
Device	V _{(BR)R} Volts	I _R	Min pF	Max pF	Cap Ratio Min	Q Min	Style	Curve Figure
ase 318E-04- inout: 1-Anod	SOT-223 e, 2, 4-Cathode	e, 3–NC	400	520	12(26)	150(28)	2	8

Table 11. Hyper-Abrupt High Capacitance Tuning Diodes — Axial Lead Glass Package

		CT @ VR		Cap Ratio	model o lecom		TiquidA-160	cv	
Device	pF Min	THE A T CALLS AND STREET AND THE PROPERTY HEREIGNESS AND THE		C2/C10 Min	2.0 V, 1.0 MHz Min	V _{(BR)R} Volts	Style	Curve Figure	
Case 51-02 - DO	-204AA (DC)-7)	11.00			70 -		THE STATE OF THE S	
MV1404	96	144	2.0	10	200	12	1 .	11	
MV1403	140	210	2.0	10	200	12	1	11	
MV1405	200	300	2.0	10	200	12	355-4T-3	11088	
(26) V _R = 1.0 V/V _R = 9 (27) V _R = 2.0 V/V _R = 1	.0 V	300	00S 83	8.8 8.8	200	38 8		8	

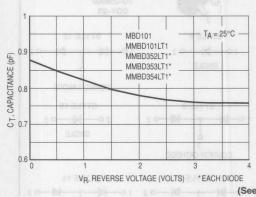
(20) V_R = 1.0 V/V_R = 9.0 V (27) V_R = 2.0 V/V_R = 10 V (28) V_R = 1.0 V, f = 1.0 MHz (29) V_R = 2.0 V, f = 1.0 MHz

Hot-Carrier (Schottky) Diodes

Hot–Carrier diodes are ideal for VHF and UHF mixer and detector applications as well as many higher frequency applications. They provide stable electrical characteristics by eliminating the point–contact diode presently used in many applications.

CASE 182-02 TO-226AC (TO - 92)STYLE 1 2 0-1 lollags onn Anode 10-10-02 Cathode Anode CASE 318-07 TO-236AB SOT-23 STYLE 8 STYLE 11 10 SINGLE STYLE 9 STYLE 19 0 2 1 0 2 SERIES COMMON CATHODE 3

Typical Characteristics Capacitance versus Reverse Voltage



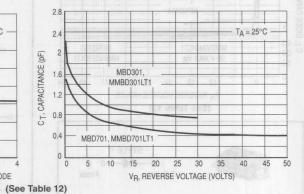


Table 12. Hot-Carrier (Schottky) Diodes

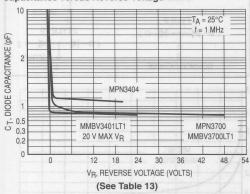
The following is a listing of hot carrier (Schottky) diodes that exhibit low forward voltage drop for improved circuit efficiency.

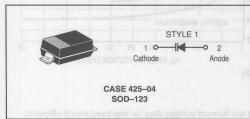
Device	V _{(BR)R} Volts	C _T @ V _R pF Max	V _F @ 10 mA Volts Max	I _R @ V _R nA Max	Minority Lifetime pS (TYP)	Device Marking	Style
Case 182-02 — TO-226	AC (TO-92)	CHOCAL				56-76897-33	
MBD701	70	1.0 @ 20 V	1.0	200 @ 35 V	15	_	1
MBD301	30	1.5 @ 15 V	0.6	200 @ 25 V	15	_	1
MBD101	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	_	ME2_	1
Case 318-07 — TO-236	AB (SOT-23)	- 16 - 0 6				E 0-16	1.6-
MMBD701LT1	70	1.0 @ 20 V	1.0	200 @ 35 V	15	5H	8
MMBD301LT1	30	1.5 @ 15 V	0.6	200 @ 25 V	15	4T	8
MMBD101LT1	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	15	4M	8
MMBD352LT1(23)	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	15	M5G	11
MMBD353LT1(23)	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	15	M4F	19
MMBD354LT1 (23)	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	15	М6Н	9
Case 425-04 — (SOD-1	23)	9.8		0		1	18/19/
MMSD701LT1	70	1.0 @ 20 V	1.2	0.2 @ 35 V	15	5H	1
MMSD301LT1	30	1.5 @ 15 V	0.6	0.2 @ 25 V	15	4T	1
MMSD101LT1	4	1.0 @ 0 V	0.6	0.25 @ 3 V	15	4M	1

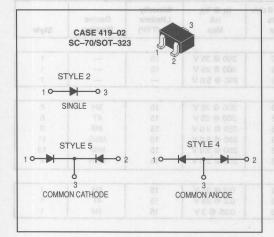
Switching Diodes

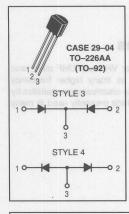
Small-signal switching diodes are intended for low current switching and steering applications. Hot-Carrier, PIN and general-purpose diodes allow a wide selection for specific application requirements.

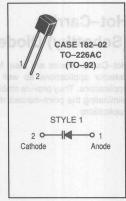
Typical Characteristics Capacitance versus Reverse Voltage

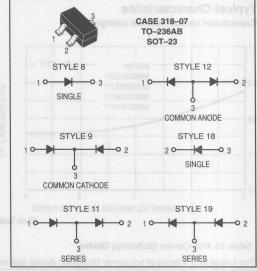


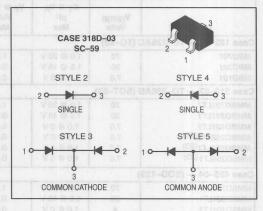












Switching Diodes (continued)

Table 13. PIN Switching Diodes

The following PIN diodes are designed for VHF band switching and general-purpose low current switching applications.

	V	CT @ VR	@ 1.0 MHz	I _R @ V _R	Series Resistance		iriotiwa Iriemi
Device	V(BR)R Volts Min	pF Max Volts		nA Max	Ohm Max	Device Marking	Style
Case 182-02 — To	D-226AC (TO-9	12)	Volts Volt	(8.0)	PAG stay	Barting	Dovice
MPN3700	200	1.0	20	0.1 @ 150	1.0 @ 10 mA	SAUGE-OT-	T0-816 sea
MPN3404	20	2.0	15	0.1 @ 25 V	0.85 @ 10 mA	1 000	T IDON TORKS
Case 318-07 — To	0-236AB (SOT-	-23)	68	1 20	78 100	SA	TTJBESSCIEMN
MMBV3700LT1	200	1.0	20	0.1 @ 150	1.0 @ 10 mA	4R	11.868 8 AMA
MMBV3401LT1	35	1.0	20	0.1 @ 25 V	0.7 @ 10 mA	4D	8

Table 14. General-Purpose Signal and Switching Diodes — Single

The following is a listing of small–signal switching diodes in surface mount packages. These diodes are intended for low current switching and signal steering applications.

Q Q.P	U.A.	V(BR)R		R		VF		CT(30)	t _{rr}	SCITATION
Device	Marking	Min Volts	@ I _{BR} (μA)	Max (μA)	@ V _R Volts	Min Volts	Max Volts	@ IF (mA)	Max (pF)	Max (ns)	Case Style
Case 318-07 -	- TO-236A	B (SOT-	-23)				- William	1	1 1 1 1	1 12 10 10	T PART N
BAS21LT1	JS	250	100	0.1	200	I -	1.0	100	5.0	50	8
MMBD914LT1	5D	100	100	5.0	75	1.0_	1.0	10	4.0	4.0	8
BAS16LT1	A6	75	100	1.0	75	1.0-	1.0	50	2.0	6.0	8
MMBD6050LT1	5A	70	100	0.1	50	0.85	1.1	100	2.5	4.0	8
BAL99LT1	JF	70	100	2.5	70	9.2	1.0	50	1.5	6.0	18
Case 318D-03	— SC-59	100	27		GS	7.0	007	08	100	LEMMIN	PARKER
M1MA151AT1	MA	40	100	0.1	35	-	1.2	100	2.0	3.0	4
M1MA151KT1	MH	40	100	0.1	35	al Ci genisib	1.2	100	2.0	3.0	2
Case 419-02 -	SC-70/S	OT-323	ηV		pl		His	ei,			
M1MA141KT1	МН	40	100	0.1	35	100/2	1.2	100	2.0	3.0	2
BAS16WT1	A6	75	1.0	0.02	20	(Aug)	1.25	150	2.0	6.0	2
M1MA142KT1	MI	80	100	0.1	75	-	1.2	100	2.0	3.0	2
Case 425-04-	SOD-123	.07	0.1		av I	200.0	hot	av	VI.	113	SASTI
MMSD914T1	5D	100	100	5.0	75		1.0	10	4.0	4.0	1

(30) $V_R = 0 V$, f = 1.0 MHz

Switching Diodes (continued)

Table 15. General-Purpose Signal and Switching Diodes — Dual

The following is a listing of small—signal switching diodes in surface mount packages. These diodes are intended for low current switching and signal steering applications.

	Baylos	٧(BR)R	An	IR		VF		CT(30)	trr	
Device	Marking	Min Volts	@ I _{BR} (μA)	Max (μA)	@ V _R Volts	Min Volts	Max Volts	@ IF (mA)	Max (pF)	Max (ns)	Case Style
Case 318-07 —	TO-236AE	(SOT-2	23)	0.1 @ 150	OS.		0.7	7 0	89	0	MIPNIEZ
MMBD7000LT1	M5C	100	100	1.0	50	0.75	1.1	100	1.5	4.0	11
MMBD2836LT1	A2	75	100	0.1	50	_	1.0	10	4.0	4.0	12
MMBD2838LT1	A6	75	100	0.1	50	-	1.0	10	4.0	4.0	9
BAV70LT1	A4	70	100	5.0	70	_	1.0	50	1.5	6.0	9
BAV99LT1	A7	70	100	2.5	70		1.0	50	1.5	4.0	11
BAW56LT1	A1	70	100	2.5	70	-	1.0	50	2.0	6.0	12
MMBD6100LT1	5BM	70	100	0.1	50	0.85	1.1	100	2.5	4.0	9
BAV74LT1	JA	50	5.0	0.1	50	stock pr	1.0	100	2.0	4.0	9
MMBD2835LT1	A3	35	100	0.1	30	80	1.0	10	4.0	4.0	12
MMBD2837LT1	A5	35	100	0.1	30	-	1.0	10	4.0	4.0	9
Case 318D-03 -	- SC-59	41.00	1	088	ave as			Land			
M1MA151WAT1	MN	40	100	0.1	35	(A.t	1.2	100	15	10	5
M1MA151WKT1	MT	40	100	0.1	35	-	1.2	100	2.0	3.0	3
Case 419-02 -	SC-70/SO	T-323	177		nos I		100	T comm	I or		120020
M1MA142WKT1	MU	80	100	0.1	75	0.2	1.2	100	2.0	3.0	5
M1MA142WAT1	MO	80	100	0.1	75	0	1.2	100	15	10	4
BAW56WT1	A1	70	100	2.5	70	1.8-	1.0	50	2.0	6.0	4
BAV70WT1	A4	70	100	5.0	70	2.5	1.0	50	1.5	6.0	5
M1MA141WKT1	MT	40	100	0.1	35	-	1.2	100	2.0	3.0	5
M1MA141WAT1	MN	40	100	0.1	35	_	1.2	100	15	10	4
3.6	0.8	001	1.2	- 1	100	1.00	- 001	THE	Ala I	TTALE	BIANAT

Table 16. Low-Leakage Medium Speed Switching Diodes — Single

		V(BR)R	1	R		VF		CT(30)	trr	Case
Device Ma	Marking	Min Volts	@ I _{BR} (μA)	Max (μA)	@ V _R Volts	Min Volts	Max Volts	@ IF (mA)	Max (pF)	Max (ns)	Case Style
Case 318-07 -	- TO-236AE	(SOT-2	23)	-	- 22	1,0	100	08	168	42577	AMIN
BAS116LT1	JV	75	100	0.005	75		1.0	10	2.0	3000	8

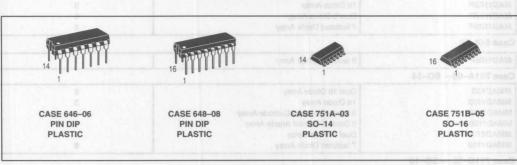
Table 17. Low-Leakage Medium Speed Switching Diodes — Dual

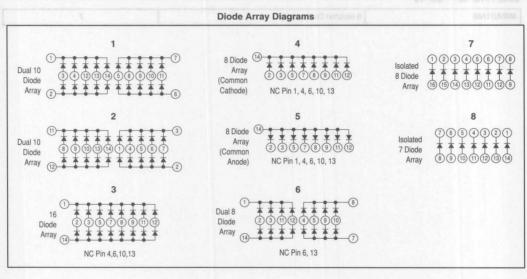
Device Marking	٧(BR)R	I _R V _F		VF		CT ⁽³⁰⁾ t _{rr}	Lev roch			
	Min Volts	@ I _{BR} (μ A)	Max (μA)	@ V _R Volts	Min Volts	Max Volts	@ IF (mA)	Max (pF)	Max (ns)	Case Style	
Case 318-07 -	- TO-236AE	(SOT-2	(3)								
BAV170LT1	JX	70	100	0.005	70	_	1.0	10	2.0	3000	9
BAV199LT1	JY	70	100	0.005	70	-	1.0	10	2.0	3000	11
BAW156LT1	JZ	70	100	0.005	70		1.0	10	2.0	3000	12

⁽³⁰⁾ V_R = 0 V, f = 1.0 MHz

Multiple Switching Diodes

Multiple diode configurations utilize monolithic structures fabricated by the planar process. They are designed to satisfy fast switching requirements as in core driver and encoding/decoding applications where their monolithic configurations offer lower cost, higher reliability and space savings.





Multiple Switching Diodes (continued)

Table 18. Diode Arrays

Case 646 — TO-116

Device	Function	Pin Connections Diagram Number
MAD130P	Dual 10 Diode Array	1
MAD1103P	16 Diode Array	3
MAD1107P	Dual 8 Diode Array	6
MAD1109P	7 Isolated Diode Array	8
Case 648-08		WAR BOOK
MAD1108P	8 Isolated Diode Array	7
Case 751A-03— SO-14		
MMAD130	Dual 10 Diode Array	2
MMAD1103	16 Diode Array	3
MMAD1105	8 Diode Common Cathode Array	CASE 874 06
MMAD1106	8 Diode Common Anode Array	5 0 419
MMAD1107	Dual 8 Diode Array	6 A.19
MMAD1109	7 Isolated Diode Array	8
Case 751B-05 — SO-16		
MMAD1108	8 Isolated Diode Array	7
		Died 10 Died 1
	S Date (S A L. A. B. TO. 45 A C. A. B. TO. 45 A	Diele Diele Arway (1997)

Section 2

Plastic-Encapsulated Transistors

In Brief ...

Motorola's plastic transistors and diodes encompass hundreds of devices spanning the gamut from general-purpose amplifiers and switches with a wide variety of characteristics to dedicated special-purpose devices for the most demanding applications. The popular TO-92, 1-Watt TO-92 and TO-116 combine proven reliability performance and economy for through-the-hole manufacturing, while the SOT-23, SC-59, SC-70/SOT-323, SOT-223, and SO-16 offer the same solutions for surface mount manufacturing.

As an additional service to our customers Motorola will, upon request, supply many of these devices in tape and reel for automatic insertion.

Contact your Motorola representative for ordering information.

This section contains both single and multiple plasticencapsulated transistors.

NOTE: All SOT-23 package devices have had a "T1" suffix added to the device title.



EMBOSSED TAPE AND REEL

SOT-23, SC-59, SC-70/SOT-323, SOT-223 and SO-16 packages are available only in Tape and Reel. Use the appropriate suffix indicated below to order any of the SOT-23, SC-59, SC-70/SOT-323, SOT-223 and SO-16 packages. (See Section 6 on Packaging for additional information).

SOT-23: available in 8 mm Tape and Reel
Use the device title (which already includes the "T1" suffix) to order the 7 inch/3000 unit reel.
Replace the "T1" suffix in the device title with a "T3" suffix to order the 13 inch/10,000 unit reel.

SC-59: available in 8 mm Tape and Reel
Use the device title (which already includes the "T1" suffix) to order the 7 inch/3000 unit reel.
Replace the "T1" suffix in the device title with a "T3" suffix to order the 13 inch/10,000 unit reel.

SC-70/ available in 8 mm Tape and Reel
SOT-323: Use the device title (which already includes the "T1" suffix) to order the 7 inch/3000 unit reel.
Replace the "T1" suffix in the device title with a "T3" suffix to order the 13 inch/10,000 unit reel.

SOT-223: available in 12 mm Tape and Reel

Use the device title (which already includes the "T1" suffix) to order the 7 inch/1000 unit reel.

Replace the "T1" suffix in the device title with a "T3" suffix to order the 13 inch/4000 unit reel.

SO-16: available in 16 mm Tape and Reel
Add an "R1" suffix to the device title to order the 7 inch/500 unit reel.
Add an "R2" suffix to the device title to order the 13 inch/2500 unit reel.

RADIAL TAPE IN FAN FOLD BOX OR REEL

TO-92 packages are available in both bulk shipments and in Radial Tape in Fan Fold Boxes or Reels.

Fan Fold Boxes and Radial Tape Reel are the best methods for capturing devices for automatic insertion in printed circuit boards.

TO-92: available in Fan Fold Box
Add an "RLR" suffix and the appropriate Style code* to the device title to order the Fan Fold box.

available in 365 mm Radial Tape Reel
Add an "RLR" suffix and the appropriate Style code* to the device title to order the Radial Tape

*Refer to Section 6 on Packaging for Style code characters and additional information on ordering requirements.

DEVICE MARKINGS/DATE CODE CHARACTERS

SOT-23, SC-59 and the SC-70/SOT-323 packages have a device marking and a date code etched on the device. The generic example below depicts both the device marking and a representation of the date code that appears on the SC-70/SOT-323, SC-59 and SOT-23 packages.



The "D" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

MAXIMUM RATINGS

The Delivery of the Control of the C			
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltge	VCBO	60	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	Ic	200	mAdc
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
*Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150	°C

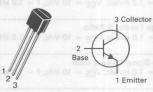
*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

^{*}Indicates Data in addition to JEDEC Requirements.

2N3903 2N3904*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	21/390	Symbol	Cal Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0)		V(BR)CEO	40	Pulse Wide	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu Adc, I_E = 0$)		V(BR)CBO	60	-	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc$, $I_C = 0$)		V(BR)EBO	6.0	the second secon	Vdc
Base Cutoff Current (V _{CE} = 30 Vdc, V _{EB} = 3.0 Vdc)	rug	IBL	+ 10.9 +	50	nAdc
Collector Cutoff Current (V _{CE} = 30 Vdc, V _{EB} = 3.0 Vdc)		ICEX	1 - x	50	nAdc
ON CHARACTERISTICS				- M- bil >	
DC Current Gain(1) (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc)	2N3903 2N3904	hFE	20 40	=	_
(I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc)	2110001	TYRICALT	35 70	=	
(I _C = 10 mAdc, V _{CE} = 1.0 Vdc)	2N3903 2N3904	ANOE	50 100	150 300	
(I _C = 50 mAdc, V _{CE} = 1.0 Vdc)	21/3904		30 60	=	
$(I_C = 100 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$	2N3903 2N3904		15 30		
Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc)	8	VCE(sat)	1 0 to	0.2 0.3	Vdc
Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc)		V _{BE} (sat)	0.65	0.85 0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz)	2N3903 2N3904	fT	250 300		MHz

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)			C _{obo}	-	4.0	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	obV	09	C _{ibo}	-	8.0	pF
Input Impedance $(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$	Väe mAde	2N3903 2N3904	oga h _{ie}	1.0	8.0 10	k ohms
Voltage Feedback Ratio $(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$	5°Wm answ	2N3903 2N3904	h _{re}	0.1 0.5	5.0 8.0	X 10-4
Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz)	200	2N3903 2N3904	hfe	50 100	200 400	Derating ab Temperati
Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)			h _{oe}	1.0 EMISTICS	40	μmhos
Noise Figure (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 1.0 k ohms, f = 1.0 kHz)	finU W\3	2N3903 2N3904	ALAR	tion to Ambient	6.0	Bb Thermal Res

SWITCHING CHARACTERISTICS

Delay Time	(V _{CC} = 3.0 Vdc, V _{BE} = 0.5 Vdc,		td	THE WANTED TO	35	ns
Rise Time I _C = 10 mAdc, I _{B1} = 1.0 mAdc)		t _r	_	35	ns	
Storage Time	$(V_{CC} = 3.0 \text{ Vdc}, I_{C} = 10 \text{ mAdc}, I_{B1} = I_{B2} = 1.0 \text{ mAdc})$	2N3903 2N3904	ts	60/15UHH1 10	175 200	ns
Fall Time			tf	_	50	ns

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 – DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

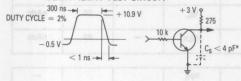
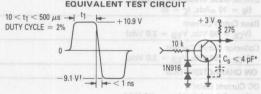


FIGURE 2 – STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



*Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

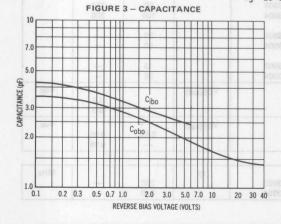
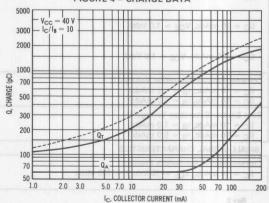
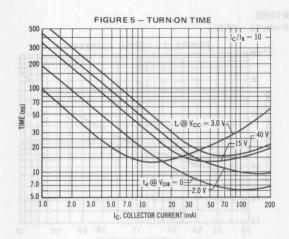
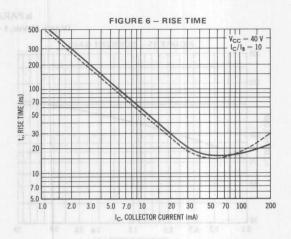
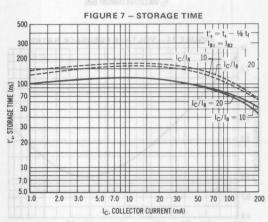


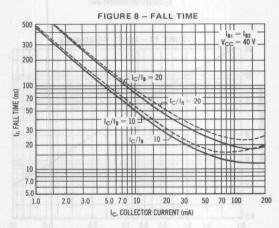
FIGURE 4 - CHARGE DATA



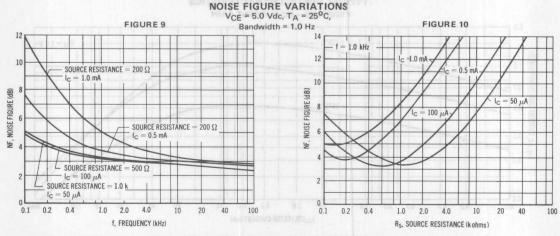






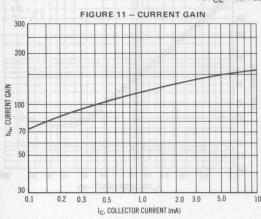


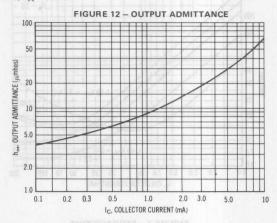
TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

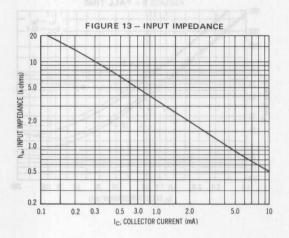


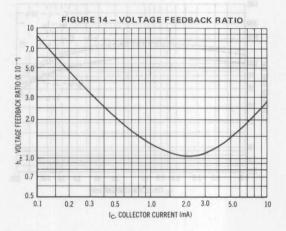
h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25^oC)

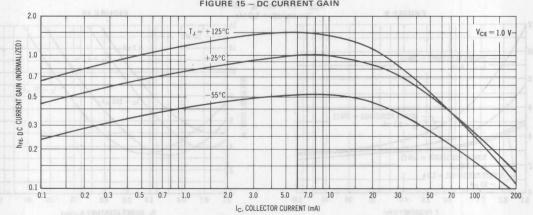


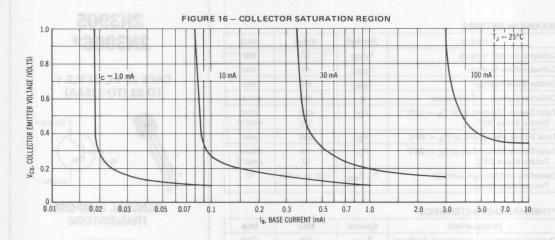


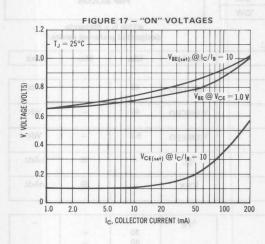


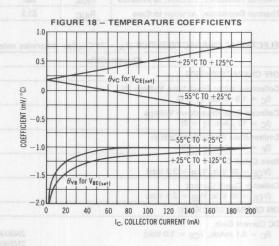


TYPICAL STATIC CHARACTERISTICS FIGURE 15 – DC CURRENT GAIN









MAXIMUM RATINGS

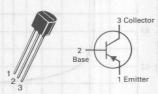
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	VCBO	40	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	IC	200	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Power Dissipation @ T _A = 60°C	PD	250	mW
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

2N3905 2N3906*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



GENERAL PURPOSE **TRANSISTORS**

PNP SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS		7			
Collector-Emitter Breakdown Voltage (1) (I _C = 1.0 mAdc, I _B = 0)	0 5 V0	V _(BR) CEO	40		Vdc
Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0)	- 66 - 65	V _(BR) CBO	40	-1	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc$, $I_C = 0$)		V _{(BR)EBO}	5.0		Vdc
Base Cutoff Current (V _{CE} = 30 Vdc, V _{EB} = 3.0 Vdc)		I _{BL}	Veries	50	nAdc
Collector Cutoff Current (VCE = 30 Vdc, VEB = 3.0 Vdc)		ICEX		50	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc)	2N3905 2N3906	hFE	30 60	-	-
(I _C = 1.0 mAdc, V_{CE} = 1.0 Vdc)	2N3905 2N3906		40 80	Ī	
(I _C = 10 mAdc, V_{CE} = 1.0 Vdc)	2N3905 2N3906		50 100	150 300	
(I _C = 50 mAdc, V_{CE} = 1.0 Vdc)	2N3905 2N3506		30 60	_	
$(I_C = 100 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$	2N3905 2N3906		15 30	_	
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc)		V _{CE(sat)}	_	0.25 0.4	Vdc
Base-Emitter Saturation Voltage (IC = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc)		VBE(sat)	0.65	0.85 0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz)	2N3905 2N3906	fT	200 250	Ξ	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}	-	4.5	pF

Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	2N3905 2N3906	fT	200 250	_	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	2110000	C _{obo}	-	4.5	pF

Rev 2

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	-008	C _{ibo}		10.0	pF
Input Impedance (I _C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3905 2N3906	h _{ie}	0.5 2.0	8.0 12	k ohms
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	2N3905 2N3906	h _{re}	0.1 0.1	5.0 10	X 10-4
Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	2N3905 2N3906	h _{fe}	50 100	200 400	
Output Admittance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz)	2N3905 2N3906	h _{oe}	1.0 3.0	40 60	μmhos
Noise Figure (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 1.0 k ohm, f = 1.0 kHz)	2N3905 2N3906	NF	DETECTOR CRANE	5.0 4.0	dB

SWITCHING CHARACTERISTICS

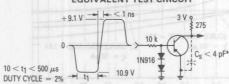
Delay Time	$(V_{CC} = 3.0 \text{ Vdc}, V_{BE} = 0.5 \text{ Vdc})$				35	ns
Rise Time	I _C = 10 mAdc, I _{B1} = 1.0 mAdc)		t _r	- 15	35	ns
Storage Time	(V _{CC} = 3.0 Vdc, I _C = 10 mAdc,	2N3905 2N3906	t _S	PIGURE 7 —	200 225	ns
Fall Time	$I_{B1} = I_{B2} = 1.0 \text{ mAdc}$	2N3905 2N3906	tf		60 75	ns

⁽¹⁾ Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 – DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

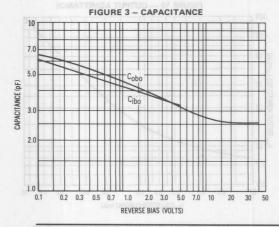


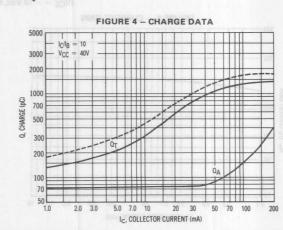
FIGURE 2 – STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



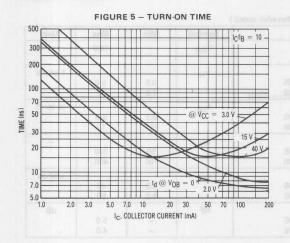
*Total shunt capacitance of test jig and connectors

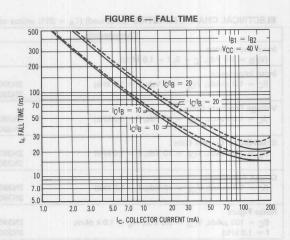
TRANSIENT CHARACTERISTICS T_J = 25°C --- T_J = 125°C



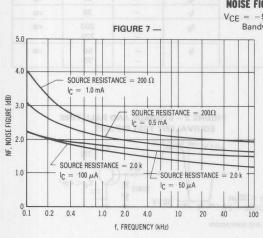


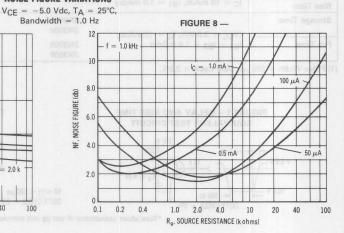
2N3905 2N3906





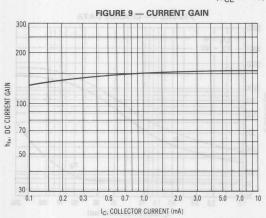
AUDIO SMALL SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

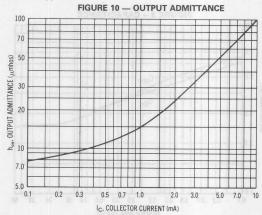




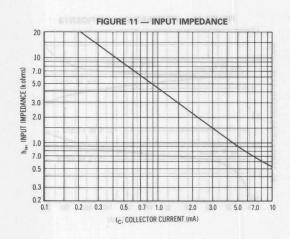
h PARAMETERS

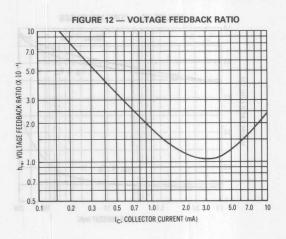
 $(V_{CE} = -10 \text{ Vdc}, f = 1.0 \text{ kHz}, T_A = 25 ^{\circ}\text{C})$



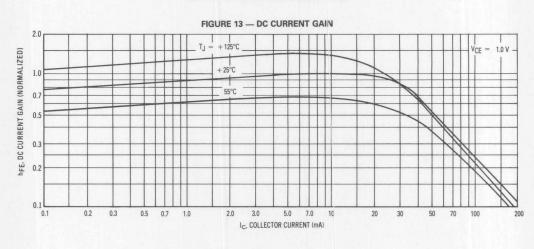


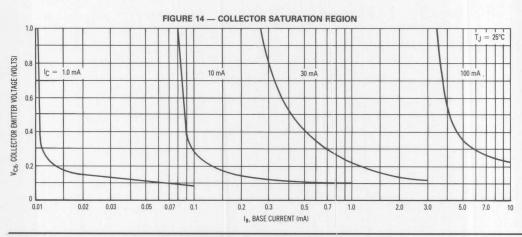
2N3905 2N3906



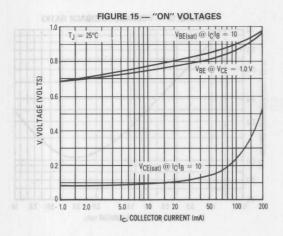


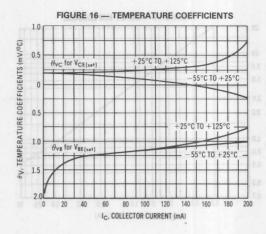
STATIC CHARACTERISTICS

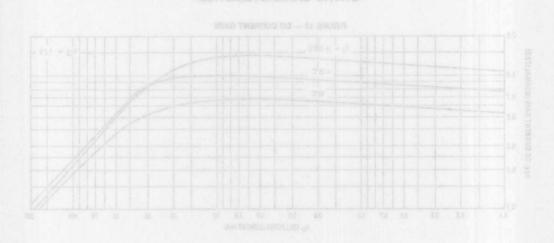


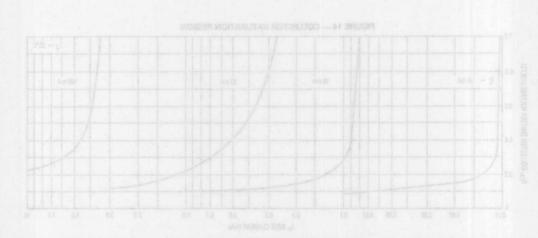


2N3905 2N3906









MAXIMUM RATINGS

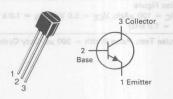
Mirotimom ratifico				
Rating	Symbol	2N4123	2N4124	Unit
Collector-Emitter Voltage	VCEO	30	25	Vdc
Collector-Base Voltage	VCBO	40	30	Vdc
Emitter-Base Voltage	VEBO	5.0		Vdc
Collector Current — Continuous	Ic	200		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

THERIVIAL CHARACTERISTICS							
Characteristic	Symbol	Max	Unit				
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W				
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W				

2N4123 2N4124

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

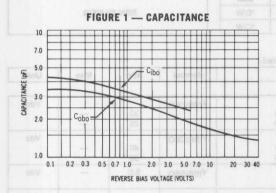
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

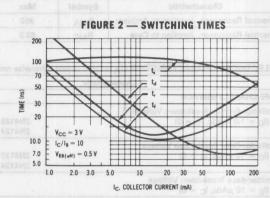
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				- 9
Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IE = 0) 2N4123 2N4124	V(BR)CEO	30 25	- 1000 A	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) 2N4123 2N4124	V(BR)CBO	40 30		Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)	V _{(BR)EBO}	5.0	-	Vdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0)	СВО	-	50	nAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0)	IEBO		50	nAdc
ON CHARACTERISTICS			MINT	
DC Current Gain(1) (IC = 2.0 mAdc, VCE = 1.0 Vdc) 2N4123 2N4124	PIE PEE	50 120	150 360	_
(I _C = 50 mAdc, V _{CE} = 1.0 Vdc) 2N4123 2N4124	1	25 60	=	
Collector-Emitter Saturation Voltage(1) (IC = 50 mAdc, I _B = 5.0 mAdc)	VCE(sat)	909381-13	0.3	Vdc
Base-Emitter Saturation Voltage(1) (I _C = 50 mAdc, I _B = 5.0 mAdc)	V _{BE} (sat)	- 2001 USTANOS - 2001	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS			Am 1 = 0 = 7	
Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) 2N4123 2N4124	fΤ	250 300	1/4	MHz
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	Cibo	NUS -	8.0	pF
Collector-Base Capacitance (I _E = 0, V _{CB} = 5.0 V, f = 1.0 MHz)	C _{cb}	L LL	4.0	pF
Small-Signal Current Gain (IC = 2.0 mAdc, VCE = 10 Vdc, RS = 10 k ohm, f = 1.0 kHz) 2N4123 2N4124	h _{fe}	50 120	200 480	7 -

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

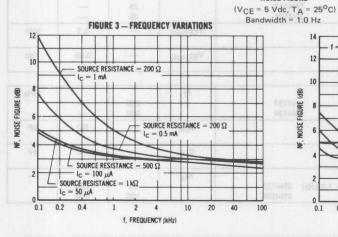
Characteristic			Symbol	Min	Max	Unit			
Current Gain — High Frequency	h _{fe}		urrent Gain — High Frequency			hfe		BATINGS	UNIXAN
$(I_C = 10 \text{ mAdc}, V_{CE} = 20 \text{ Vdc}, f = 100 \text{ MHz})$		2N4123 2N4124		Byrnbol	2.5 3.0	Reting			
		2.5		VCEO		iner Vollage	ni3-rotoelle		
$(I_C = 2.0 \text{ mAdc, V}_{CE} = 10 \text{ V, f} = 1.0 \text{ kHz})$ $(I_C = 2.0 \text{ mAdc, V}_{CE} = 10 \text{ V, f} = 1.0 \text{ kHz})$	Vdo	2N4123 2N4124	03	083V	50 120	200 480	n 8-rotpello		
Noise Figure (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 1.0 k ohm,		2N4123		NF NF	Bliour	6.0	dB		
f = 1.0 kHz		2N4124		09	TA- 25°C	5.0	polysol larg		

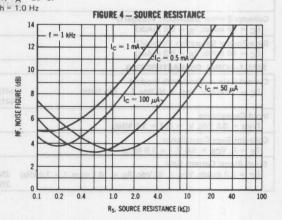
⁽¹⁾ Pulse Test: Pulse Width = 300 μ s. Duty Cycle = 2.0%.





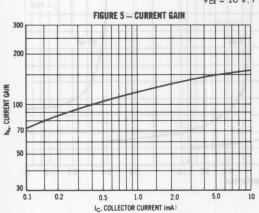
AUDIO SMALL SIGNAL CHARACTERISTICS NOISE FIGURE

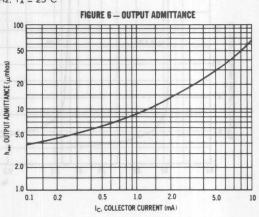


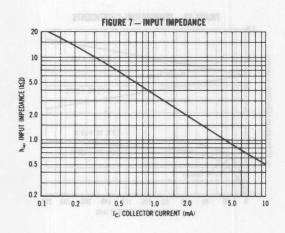


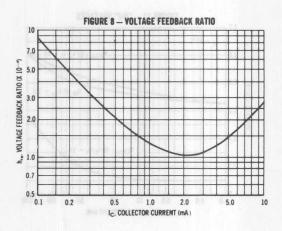
h PARAMETERS





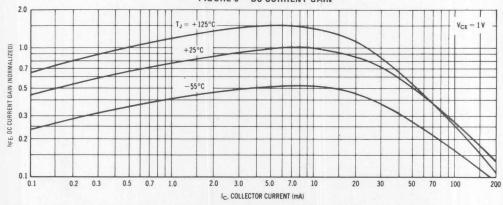


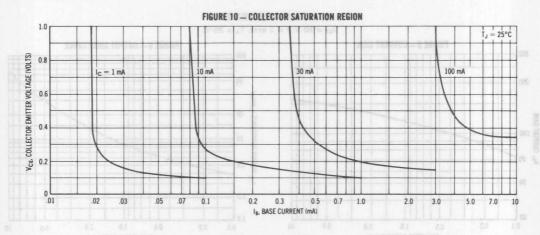


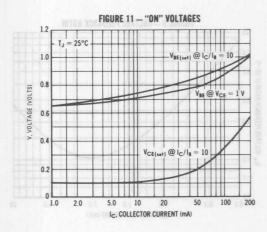


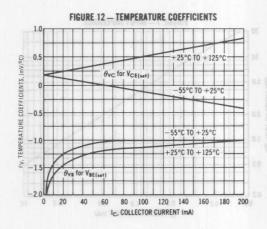
STATIC CHARACTERISTICS

FIGURE 9 - DC CURRENT GAIN









MAXIMUM RATINGS

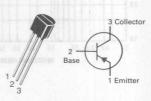
WAXIWOW RATINGS							
Rating	Symbol	2N4125	2N4126	Unit			
Collector-Emitter Voltage	VCEO	30	25	Vdc			
Collector-Base Voltage	VCBO	30	25	Vdc			
Emitter-Base Voltage	VEBO	4	.0	Vdc			
Collector Current - Continuous	Ic	200		mAdc			
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW/°C			
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12.0		Watt mW/°0			
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C			

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit						
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W						
Thermal Resistance, Junction to Case	Reic	83.3	°C/W						

2N4125 2N4126

CASE 29-04, STYLE 1 TO-92 (TO-226AA)

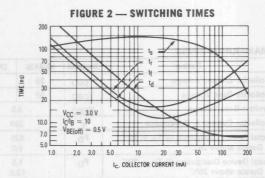


AMPLIFIER TRANSISTORS

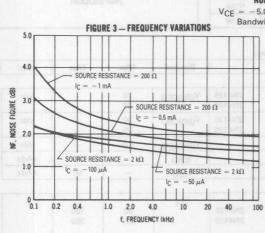
PNP SILICON

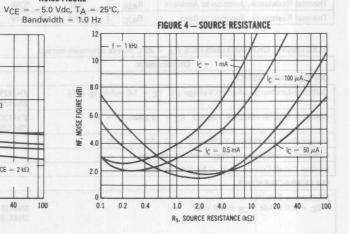
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS			No. of S. State Contract	The state of the s	9/
Collector-Emitter Breakdown Voltage (1) ($I_C = 1.0 \text{ mAdc}, I_E$	= 0) 2N4125 2N4126	V _(BR) CEO	30 25	+±/	Vdc
Collector-Base Breakdown Voltage $(I_C = 10 \mu Adc, I_E = 0)$	2N4125 2N4126	V _(BR) CBO	30 25	11	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	W LL	V(BR)EBO	4.0	4	Vdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0)		ICBO	DAG - 2004	50	nAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0)	1007 = 3010	IEBO		50	nAdc
ON CHARACTERISTICS		ALM-123			
DC Current Gain(1) (I _C = 2.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 50 mAdc, V _{CF} = 1.0 Vdc)	2N4125 2N4126 2N4125	hFE	50 120 25	150 360	1.0
(IC = 50 MAGE, VCE = 1.0 VGE)	2N4126		60		
Collector-Emitter Saturation Voltage (1) (I _C = 50 mAdc, I _B = 5.0 mAdc)		V _{CE(sat)}	-	0.4	Vdc
Base-Emitter Saturation Voltage(1) (I _C = 50 mAdc, I _B = 5.0 mAdc)	H PARAMETER	V _{BE(sat)}		0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS		READ TOOM	EDO — E RAUE	19	
Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz)	2N4125 2N4126	fΤ	200 250		MHz
Input Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz)		C _{ibo}		10	pF
Collector-Base Capacitance (V _{CB} = 5.0 V _{dc} , I _E = 0, f = 1.0 MHz)		C _{cb}		4.5	pF
Small-Signal Current Gain (IC = 2.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz)	2N4125 2N4126	h _{fe}	50 120	200 480	00
Current Gain — High Frequency (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	2N4125 2N4126	h _{fe}	2.0 2.5		Tot
Noise Figure (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 1.0 k ohm, f = 1.0 KHz)	2N4125 2N4126	NF	81 _ 81	5.0 4.0	dB

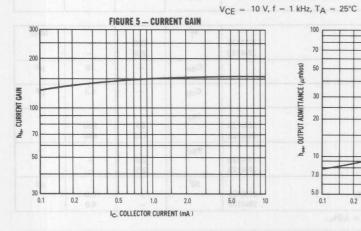


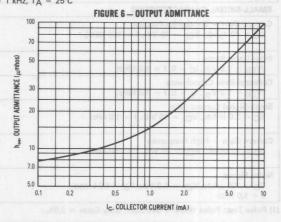
AUDIO SMALL SIGNAL CHARACTERISTICS NOISE FIGURE

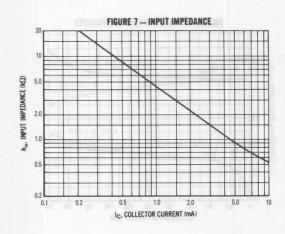


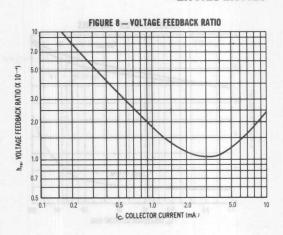


h PARAMETERS

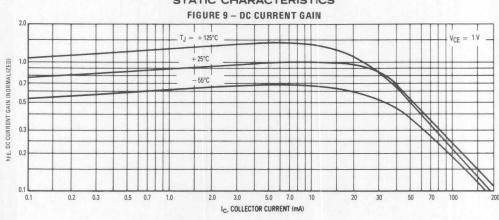


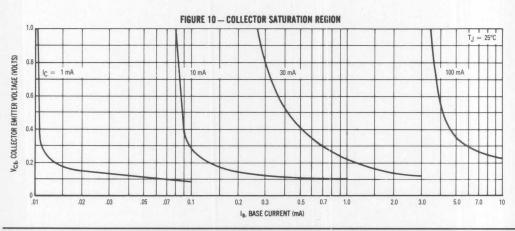


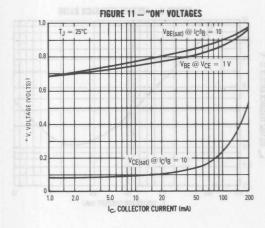


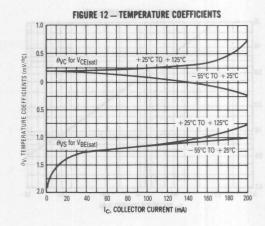


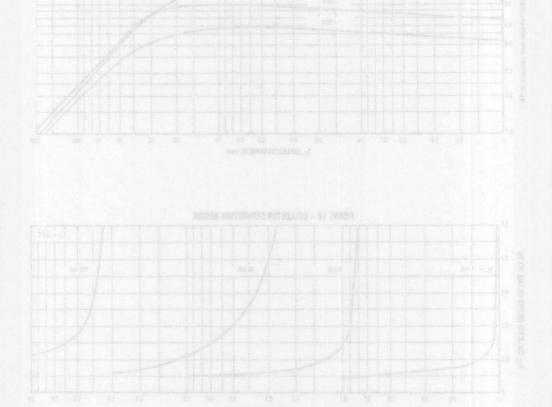
STATIC CHARACTERISTICS











MAXIMUM RATINGS

Characteristic	Symbol	2N4264	2N4265	Unit		
Collector-Emitter Voltage	VCEO	15	12	Vdc		
Collector-Base Voltage	VCBO	3	30	Vdc		
Emitter-Base Voltage	VEBO	6.0		6.0		Vdc
Collector Current — Continuous	do lc	200		mAdc		
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8		mW mW/°C		
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0 (3 not) 8.0 3 seeT		Watts mW/°C		
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150		(2°C)		

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

2N4264 2N4265

CASE 29-04, STYLE 1 TO-92 (TO-226AA)





GENERAL PURPOSE TRANSISTORS

NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0 \text{ mAdc}, I_E = 0$)	2N4264 2N4265	V(BR)CEO	15 12	_	Vdc
Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _C = 0)		V _(BR) CBO	30	-	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0)		V _{(BR)EBO}	6.0		Vdc
Base Cutoff Current (V _{CE} = 12 Vdc, V _{EB{off}} = 0.25 Vdc) (V _{CE} = 12 Vdc, V _{EB{off}} = 0.25 Vdc, T _A = 100°C)		IBEV	=	0.1 10	μAdo
Collector Cutoff Current (VCE = 12 Vdc, VEB(off) = 0.25 Vdc)		ICEX	_	100	nAdo

ON CHARACTERISTICS

DC Current Gain		hFE			_
(I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc)	2N4264		25		Tagr
	2N4265	Y mouseVip	50	ic Vice Rs	MOTFIGMO
$(I_C = 10 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$	2N4264	VV	40	160	
	2N4265	-appr a.r-	100	400	A
$(I_C = 10 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}, T_A = -55^{\circ}C)$	2N4264		20	10 580	
10 - 10 made, VCE - 1.0 Vde, 1A - 33 c/	2N4265	-2.0 635	45	00 10 580	0
(I _C = 30 mAdc, V _{CF} = 1.0 Vdc)	2N4264		40	_	XI as
, C	2N4265		90	_	Mary 1
(I _C = 100 mAdc, V _{CF} = 1.0 Vdc)(1)	2N4264		30	_	
	2N4265		55	-	
(I _C = 200 mAdc, V _{CF} = 1.0 Vdc)(1)	2N4264		20		
	2N4265		55	-	
Collector-Emitter Saturation Voltage		V _{CE(sat)}			Vdc
$(I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc})$			_	0.22	
$(I_C = 100 \text{ mAdc}, I_B = 10 \text{ mAdc})(1)$				0.35	
Base-Emitter Saturation Voltage		VBE(sat)			Vdc
$(I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc})$			0.65	0.8	
$(I_C = 100 \text{ mAdc}, I_B = 10 \text{ mAdc})(1)$			0.75	0.95	

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

	Characteristic	Symbol	Min	Max	Unit		
SMALL-SIGNAL CHAR	ACTERISTICS						TO 120 NO YOU
Current-Gain — Bandv (I _C = 10 mAdc, V _{CE}	vidth Product = 10 Vdc, f = 100 MHz)	obV	15 12	fT	300	Irrar Voltage	MHz
Input Capacitance (VEB = 0.5 Vdc, IC	= 0, f = 1.0 MHz)	- 26V	0.8	C _{ibo}	-	8.0	pF
Output Capacitance (V _{CB} = 5.0 Vdc, I _E =	= 0, f = 1.0 MHz, I _E = 0)	ptsArm	200	C _{obo}	Taroun	4.0	pF
SWITCHING CHARACT	TERISTICS	orwin-	2.8		202	25.0vc	Derate ab
Delay Time	(V _{CC} = 10 Vdc, V _{EB(off)} =	2.0 Vdc,	1.0	t _d	8 Tc- 25'C	8.0	ns
Rise Time	$I_C = 100 \text{ mAdc}, I_{B1} = 10 \text{ n}$, Test Condition C)	t _r	_	15	ns
Storage Time	V _{CC} = 10 Vdc, (I _C = 10 m/	Adc, for t _s)	-85 to +150	ts	notion.	20	ns
Fall Time	$(I_C = 100 \text{ mA for } t_f)$ $(I_{B1} = -10 \text{ mA}) (I_{B2} = 10)$	mA) (Fig. 1,	tf	_	15	ns	
Turn-On Time	(V _{CC} = 3.0 Vdc, V _{EB(off)} = I _C = 10 mAdc, I _{B1} = 3.0 m		ton	RETICS	25	ns	
Turn-Off Time	$(V_{CC} = 3.0 \text{ Vdc}, I_{C} = 10 \text{ m})$ $I_{B1} = 3.0 \text{ mAdc}, I_{B2} = 1.5$		toff m	alion to Ambe	35	ns ns	
Storage Time	$(V_{CC} = 10 \text{ Vdc}, I_{C} = 10 \text{ m/s})$ $I_{B1} = I_{B2} = 10 \text{ mAdc}) (Fig.$		t _s	2.50 O 11011	20	ns	
Total Control Charge	(V _{CC} = 3.0 Vdc, I _C = 10 m (Fig. 3, Test Condition A)	Adc, I _B = m.	Adc)	Ωт	r sorraina	80	pC

⁽¹⁾ Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

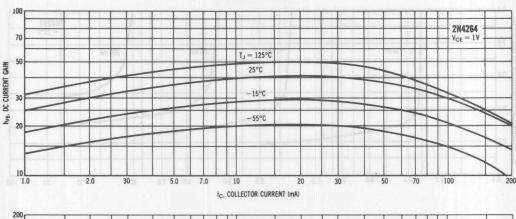
FIGURE 1 — SWITCHING TIME EQUIVALENT TEST CIRCUIT

												ton .	toff t
TEST CONDITION	Ic	Vcc	Rs	RC	CS	max)	V _{BE(off)}	V ₁	V ₂	V ₃		V ₁ —	V ₃ — R _C
	mA	٧	Ω	Ω	06.	oF.	V	V	V	V		0/-	0 RB -i-
Α	10	3	3300	270	101	4	-1.5	10.55	-4.15	10.70	VE	8(off)	V ₂
В	10	10	560	960	nic.	4	_	_	-4.65	6.55		-<2 ns	< 2 ns
С	100	10	560	96	SID.	12	-2.0	6.35	-4.65	6.55		PULSE WIDTH $(t_i) = 300 \text{ ns}$	DUTY CYCLE = 2%

ON CHARACTERISTICS

CURRENT GAIN CHARACTERISTICS

FIGURE 2 — MINIMUM CURRENT GAIN



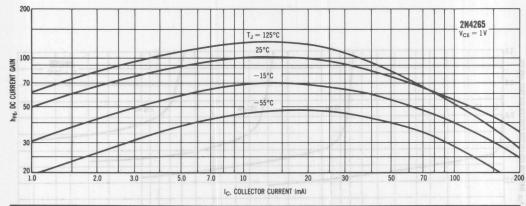


FIGURE 3 - QT TEST CIRCUIT

270 Ω +10V 9.2 kΩ **→**<1 ns PULSE WIDTH (t₁) = $5 \,\mu s$ DUTY CYCLE = 2%

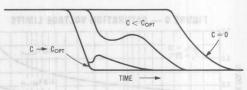
NOTE 1

When a transistor is held in a conductive state by a base current, $I_{\text{B}},$ a charge, $Q_{\text{S}},$ is developed or "stored" in the transistor. Q_{S} may be written: $Q_{\text{S}}=Q_{\text{I}}+Q_{\text{Y}}+Q_{\text{X}}.$ Q_{I} is the charge required to develop the required collector current. This charge is primarily a function of alpha cutoff frequency. Q_{Y} is the charge required to charge the collector-base feedback capacity. Qx is excess charge resulting from overdrive, i.e., operation in saturation

The charge required to turn a transistor "on" to the edge of saturation is the sum of Q_1 and Q_{ν} which is defined as the active region charge, Q_{A} . $Q_{A}=I_{B}I_{\nu}$ when the transistor is driven by a constant cur-

rent step (I_BI) and I_BI $<<\frac{I_{C}}{h_{FE}}$

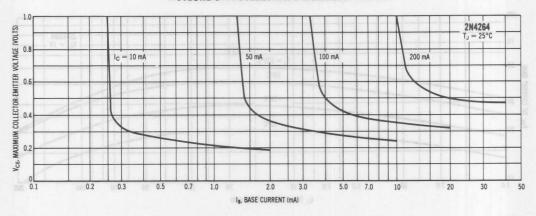
FIGURE 4 — TURN-OFF WAVEFORM

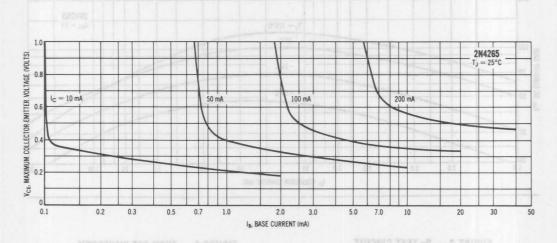


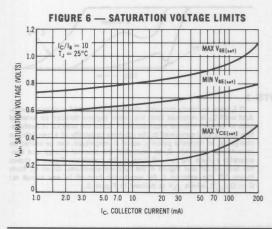
If I₈ were suddenly removed, the transistor would continue to conduct until Qs is removed from the active regions through an external path or through internal recombination. Since the internal recombination time is long compared to the ultimate capability of a transistor, a charge, Q_T , of opposite polarity, equal in magnitude, can be stored on an external capacitor, C, to neutralize the internal charge and considerably reduce the turn-off time of the transistor. Figure 3 shows the test circuit and Figure 4 the turn-off waveform. Given Q_{τ} from Figure 13, the external C for worst-case turn-off in any circuit is: $C=Q_{1}/_{\textstyle\triangle}V,$ where $_{\textstyle\triangle}V$ is defined in Figure 3.

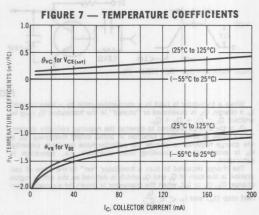
"ON" CONDITION CHARACTERISTICS

FIGURE 5 — COLLECTOR SATURATION REGION

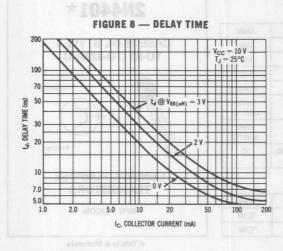


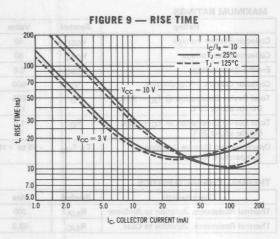


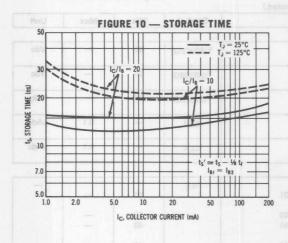


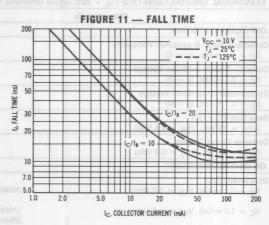


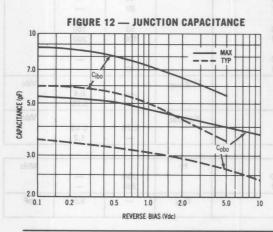
DYNAMIC CHARACTERISTICS

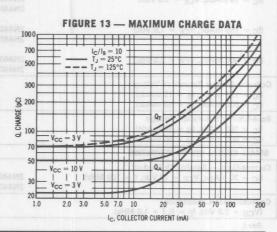












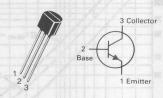
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	VCBO	60	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	Ic	600	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	ReJC	83.3	°C/W

2N4400 2N4401*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit	
OFF CHARACTERISTICS	200		11111	1 11111		100
Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0)		1 5 5 -	V _{(BR)CEO}	40		Vdc
Collector-Base Breakdown Voltage (I _C = 0.1 mAdc, I _E = 0)	or		V _(BR) CBO	60		Vdc
Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0)	08.03		V _{(BR)EBO}	6.0		Vdc
Base Cutoff Current (V _{CE} = 35 Vdc, V _{EB} = 0.4 Vdc)	05 = 0		IBEV	-	0.1	μAdc
Collector Cutoff Current (V _{CE} = 35 Vdc, V _{EB} = 0.4 Vdc)			ICEX		0.1	μAdc
ON CHARACTERISTICS(1)			a -			7.0
DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc)	2N4401	601	hFE	20	2 0.5	5.0
$(I_C = 1.0 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$	2N4400 2N4401		(Ua) 19(5)(II	20 40	=	
$(I_C = 10 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$	2N4400 2N4401			40 80	Ξ	
$(I_C = 150 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$	2N4400 2N4401		SVANO MOTA	50 100	150 300	01
$(I_C = 500 \text{ mAdc}, V_{CE} = 2.0 \text{ Vdc})$	2N4400 2N4401			20 40		0.3
Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc)	- 006 E		VCE(sat)		0.4 0.75	Vdc
Base-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc)			V _{BE(sat)}	0.75 —	0.95 1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS		pdo-		4		3.0
Current-Gain — Bandwidth Product (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	2N4400 2N4401		fΤ	200 250		MHz
Collector-Base Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	0.1 06	5.0	C _{cb}	0.5 - 1.0	6.5	pF

DYNAMIC CHARACTERISTICS

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

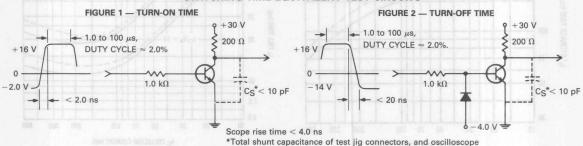
Characteristic	g 001	Symbol	Min	Max	Unit
Emitter-Base Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	05	C _{eb}		30	pF
Input Impedance ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	2N4400 2N4401	h _{ie}	0.5 1.0	7.5 15	k ohms
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)		h _{re}	0.1	8.0	X 10-4
Small-Signal Current Gain (IC = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N4400 2N4401	h _{fe}	20 40	250 500	01
Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)		h _{oe}	1.0	30	μmhos

SWITCHING CHARACTERISTICS

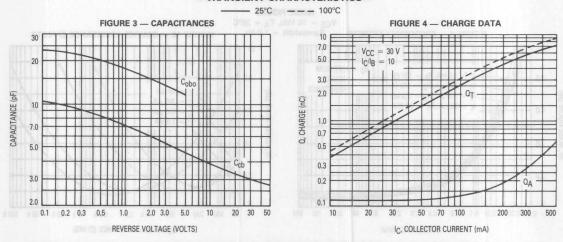
Delay Time (V _{CC} = 30 Vdc, V _{BE} = 2.0 Vdc,		000 td 000	· · · · · · · · · · · · · · · · · · ·	15	0 ns
Rise Time	I _C = 150 mAdc, I _{B1} = 15 mAdc)	t _r	LO ROTUELLOS	20	ns
Storage Time	$(V_{CC} = 30 \text{ Vdc}, I_{C} = 150 \text{ mAdc},$	t _S		225	ns
Fall Time	$I_{B1} = I_{B2} = 15 \text{ mAdc}$	tf	_	30	ns

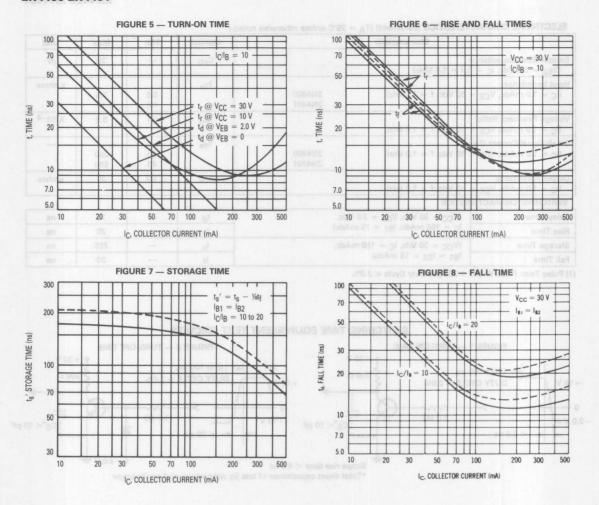
(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

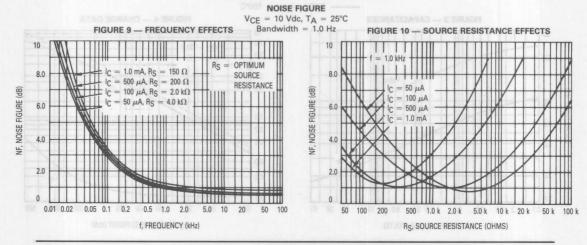


TRANSIENT CHARACTERISTICS





SMALL-SIGNAL CHARACTERISTICS

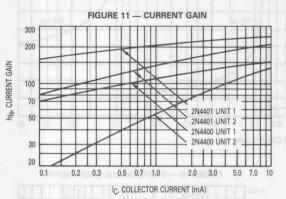


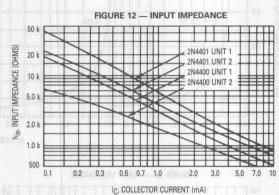
h PARAMETERS

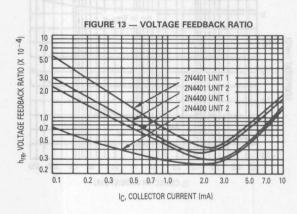
 $V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz}, T_A = 25^{\circ}\text{C}$

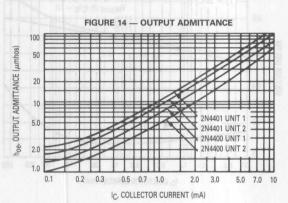
This group of graphs illustrates the relationship between hfe and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were

selected from both the 2N4400 and 2N4401 lines, and the same units were used to develop the correspondingly numbered curves on each graph.



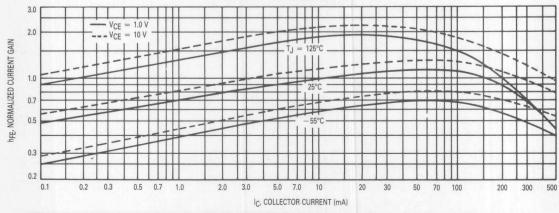




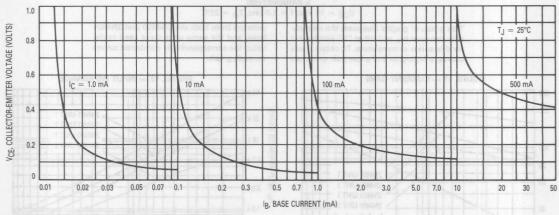


STATIC CHARACTERISTICS

FIGURE 15 — DC CURRENT GAIN









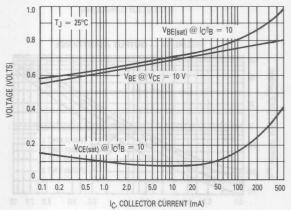
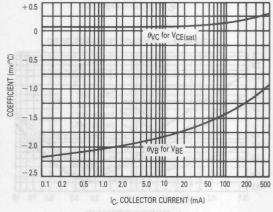


FIGURE 18 — TEMPERATURE COEFFICIENTS



Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	V _{CBO}	40	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current - Continuous	Ic	600	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	P _D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

2N4402 2N4403*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.) Characteristic Sym

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAd	c, I _B = 0)	V(BR)CEO	40	_	Vdc
Collector-Base Breakdown Voltage (I _C = 0.1 mAdc, I _E	= 0)	V(BR)CBO	40	_	Vdc
Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C =	0)	V(BR)EBO	5.0	- K	Vdc
Base Cutoff Current (V _{CE} = 35 Vdc, V _{EB} = 0.4 Vdc)	1 80-0	IBEV	_	0.1	μAdc
Collector Cutoff Current (V _{CE} = 35 Vdc, V _{EB} = 0.4 Vdc	c)	ICEX		0.1	μAdc
ON CHARACTERISTICS	go part to constitute a hard- for		97 3,210 (310)	20,031,012	4
DC Current Gain ($I_C = 0.1 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$)	2N4403	hFE	30	-	-
(I _C = 1.0 mAdc, V_{CE} = 1.0 Vdc)	2N4402 2N4403		30 60	_	
$(I_C = 10 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$	2N4402 2N4403		50 100	=	
$(I_C = 150 \text{ mAdc}, V_{CE} = 2.0 \text{ Vdc})(1)$	2N4402 2N4403	TRANS	50 100	150 300	
$(I_C = 500 \text{ mAdc}, V_{CE} = 2.0 \text{ Vdc})(1)$	Both	230007000	20	-	
Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, I _B = 15 mAdc) (IC = 500 mAdc, I _B = 50 mAdc)	01 UT 02	VCE(sat)		0.4 0.75	Vdc
Base-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc)		VBE(sat)	0.75	0.95 1.3	Vdc
SMALL SIGNAL CHARACTERISTICS			25		1 10
Current-Gain — Bandwidth Product (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	2N4402 2N4403	ft	150 200	-	MHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		C _{cb}		8.5	pF
Emitter-Base Capacitance $(V_{EB}=0.5\ V_{C}=0, f=1.0\ MHz)$		C _{eb}		30	pF
Input Impedance (IC = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N4402 2N4403	hie	750 1.5k	7.5k 15k	ohms

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

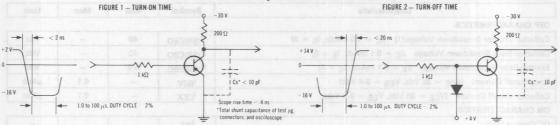
Characteristic			Symbol	Min	Max	Unit
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)		V days	h _{re}	0.1	8.0	X 10-4
Small-Signal Current Gain (I $_{\mbox{\scriptsize C}}=1.0$ mAdc, V $_{\mbox{\scriptsize CE}}=10$ Vdc, f = 1.0 kHz)	styV	2N4402	h _{fe}	30	250	ind-sofoelle
		2N4403	DESV	60	500	degror-Car
Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	Vde	5,0	h _{oe}	1.0	100	μmhos

SWITCHING CHARACTERISTICS

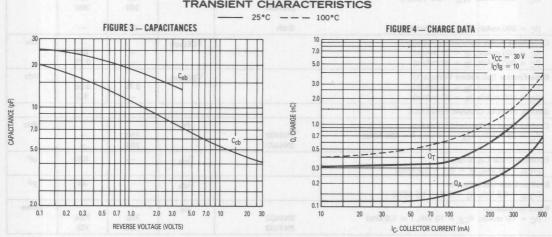
Delay Time	(V _{CC} = 30 Vdc, V _{BE} = +2.0 Vdc,		t _d	- "	15	ns
Rise Time	I _C = 150 mAdc, I _{B1} = 15 mAdc)		ng t _r	oras - at o	20	ns
Storage Time	(V _{CC} = 30 Vdc, I _C = 150 mAdc,	51	t _S	-	225	ns
Fall Time	I _{B1} = 15 mA, I _{B2} = 15 mA)		tf	<u>mollom</u>	30	ns

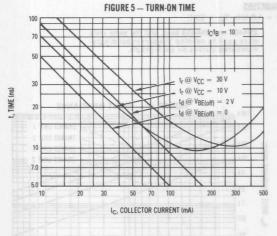
⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

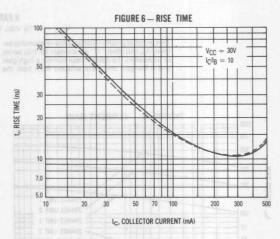
SWITCHING TIME EQUIVALENT TEST CIRCUIT

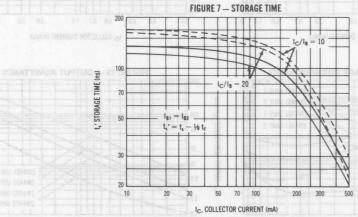


TRANSIENT CHARACTERISTICS

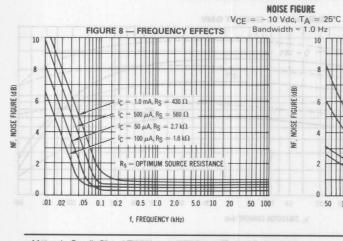


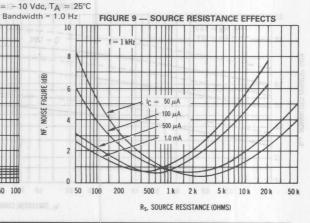






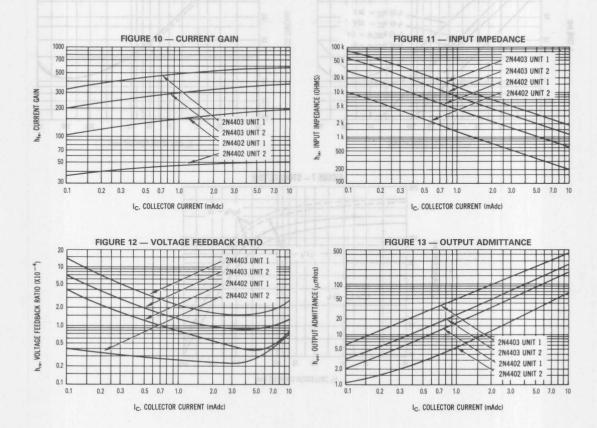
SMALL-SIGNAL CHARACTERISTICS



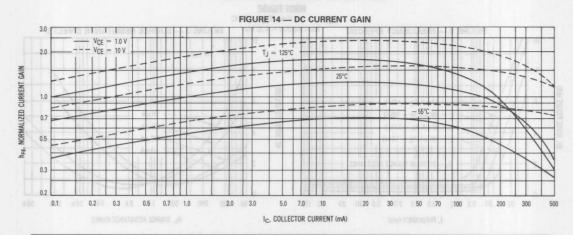


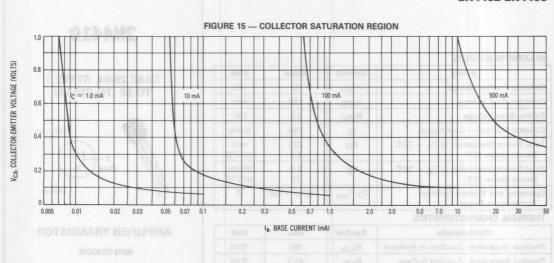
This group of graphs illustrates the relationship between $h_{\rm p}$ and other "h" parameters for this series of transistors. To obtain these curves, a high gain and a low-gain unit were selected from both the

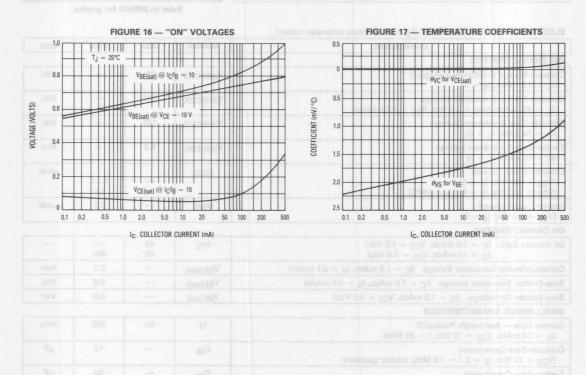
2N4402 and 2N4403 lines, and the same units were used to develop the correspondingly-numbered curves on each graph.



STATIC CHARACTERISTICS







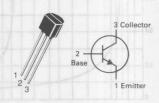
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	80	Vdc
Collector-Base Voltage	V _{CBO}	120	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	IC	250	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	R_{θ} JC	83.3	°C/W

2N4410

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N5550 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS			78 - 17 +	
Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0)	V _(BR) CEO	80		Vdc
Collector-Emitter Breakdown Voltage (I _C = 500 μAdc, V _{BE} = 5.0 Vdc, R _{BE} = 8.2 k ohms)	V _(BR) CEX	120		Vdc
Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0)	V _(BR) CBO	120		Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V _{(BR)EBO}	5.0		Vdc
Collector Cutoff Current (V _{CB} = 100 Vdc, I _E = 0) (V _{CB} = 100 Vdc, I _E = 0, T _A = 100 $^{\circ}$ C)	Ісво	11 L	0.01 1.0	μAdc
Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0)	I _{EBO}	101 ± 11	0.1	μAdc
ON CHARACTERISTICS	(SA) TWRESIN	ecration	2 1 7 2 3	
DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc)	hFE	60 60	400	-
Collector-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 0.1 mAdc)	V _{CE(sat)}	_	0.2	Vdc
Base-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 0.1 mAdc)	V _{BE(sat)}	_	0.8	Vdc
Base-Emitter On Voltage $(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$	V _{BE(on)}		0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current Gain — Bandwidth Product(2) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 20 MHz)	fT	60	300	MHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz, emitter guarded)	C _{cb}	-	12	pF
Emitter-Base Capacitance (VEB = 0.5 Vdc , IC = 0 , f = 1.0 MHz , collector guarded)	C _{eb}	-	50	pF

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

⁽²⁾ f_T = |h_{fe}| • f_{test}.

			and the second
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	50	Vdc
Collector-Base Voltage	Vсво	50	Vdc
Emitter-Base Voltage	VEBO	3.0	Vdc
Collector Current — Continuous	Ic	50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max 00	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta,JC}$	83.3	°C/W

2N5086 2N5087*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

★This is a Motorola

designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	9 11 11		MIH DE		4 00
Collector-Emitter Breakdown Voltage(2) (I _C = 1.0 mAdc, I _B = 0)	×08 \$	V(BR)CEO	50	1/1	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	10.3 %	V(BR)CBO	50		Vdc
Collector Cutoff Current (VCB = 35 Vdc, I _E = 0)	101 g 11 Q	СВО		50	nAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0)	005 HV 0.4	I _{EBO}	Hit	50	nAdc
ON CHARACTERISTICS	91 101 101 10E	200 300	00 70 100	E 17	QF.
DC Current Gain (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc)	2N5086 2N5087	hFE	150 250	500 800	-
(I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc)	2N5086 2N5087	DEBAND	150 250		1005
$(I_{C} = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})(2)$	2N5086 2N5087		150 250		200 k
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)		VCE(sat)		0.3	Vdc
Base-Emitter On Voltage (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc)	100	V _{BE(on)}	0.5.00	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS	P C	811 0.1			2.0%
Current Gain — Bandwidth Product (I _C = 500 μ Adc, V _{CE} = 5.0 Vdc, f = 20 MHz)	X TOTAL	ÍΤ	40		MHz
Collector-Base Capacitance (VCB = 5.0 Vdc, IE = 0, f = 1.0 MHz)	10 m 10 m R S	C _{cb}	50 70 100	4.0	pF
Small-Signal Current Gain (IC = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N5086 2N5087	h _{fe}	150 250	600 900	-
Noise Figure (I _C = 20 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k ohms, f = 1.0 kHz)	2N5086 2N5087	NF	_	3.0 2.0	dB
(I $_{\mbox{\scriptsize C}}=$ 100 $\mu\mbox{\scriptsize Adc},$ V $_{\mbox{\scriptsize CE}}=$ 5.0 Vdc, R $_{\mbox{\scriptsize S}}=$ 3.0 k ohms, f $=$ 1.0 kHz)	2N5086 2N5087			3.0 2.0	

(2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

TYPICAL NOISE CHARACTERISTICS $(V_{CE} = -5.0 \text{ Vdc}, T_A = 25^{\circ}\text{C})$

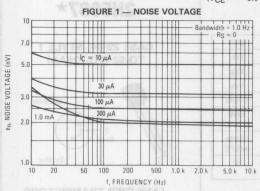
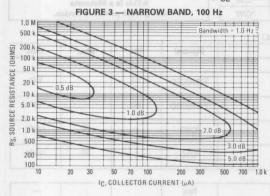
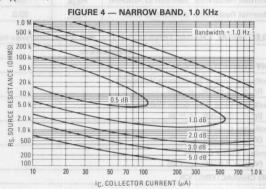
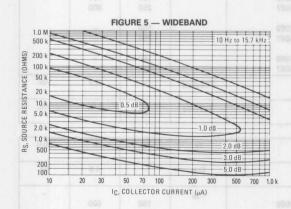


FIGURE 2 — NOISE CURRENT Bandwidth = 1.0 Hz 7.0 -R_S ≈ ∞ 5.0 Ic = 1.0 mA 3.0 2.0 300 μΑ 1.0 0.7 100 μΑ VOISE 0.5 30 μΑ 0.3 0.2 01 10 50 100 200 500 1.0 k 2.0 k 5.0 k 10 k f, FREQUENCY (Hz)

NOISE FIGURE CONTOURS $(V_{CE} = -5.0 \text{ Vdc}, T_A = 25^{\circ}\text{C})$







Noise Figure is Defined as:

$$\text{NF} = 20 \; \text{log}_{10} \left[\frac{e_n^2 + 4 \text{KTR}_S + \text{I}_n^2 \text{R}_S^2}{4 \text{KTR}_S} \right] \; ^{1/2}$$

en = Noise Voltage of the Transistor referred to the input. (Figure 3)

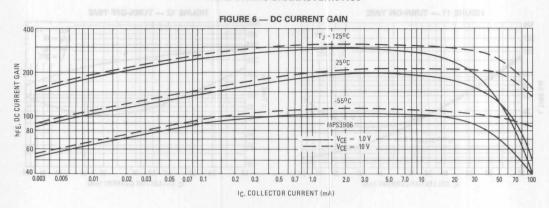
= Noise Current of the transistor referred to the input (Figure 4)

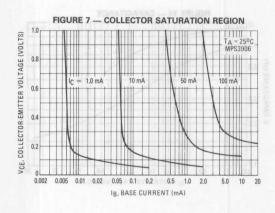
 $K = Boltzman's Constant (1.38 \times 10^{-23} i/^{0}K)$

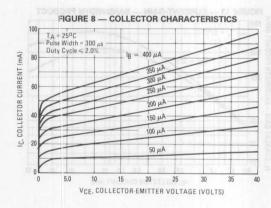
T = Temperature of the Source Resistance (OK)

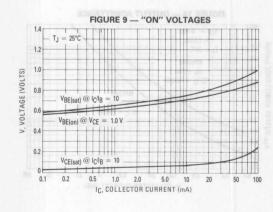
Rs = Source Resistance (Ohms) methods 1 and appeal of

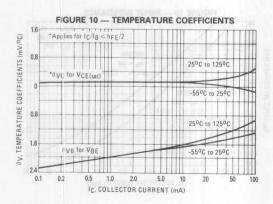
TYPICAL STATIC CHARACTERISTICS



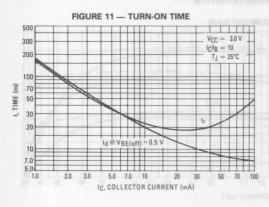


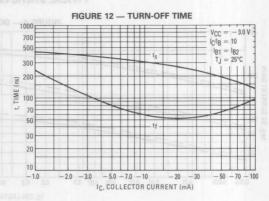


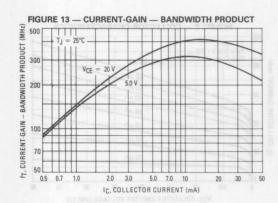


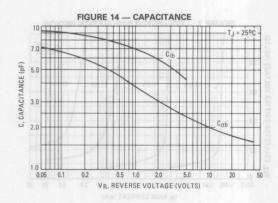


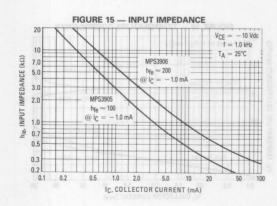
TYPICAL DYNAMIC CHARACTERISTICS

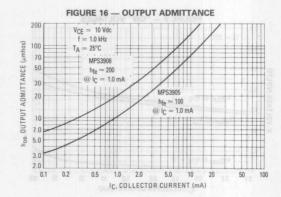














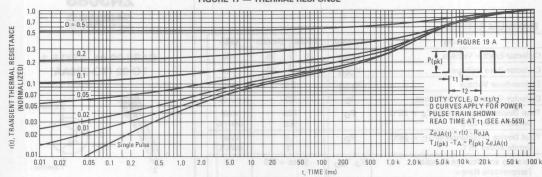
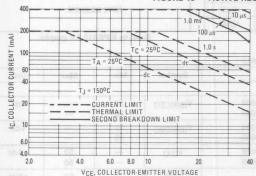


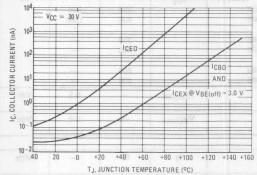
FIGURE 18 — ACTIVE-REGION SAFE OPERATING AREA



The safe operating area curves indicate IC-VCE limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 20 is based upon $T_{J(pk)} = 150^{\circ}C$; T_{C} or T_{A} is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \le 150^{\circ}C$. $T_{J(pk)}$ may be calculated from the data in Figure 19. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown

FIGURE 19 — TYPICAL COLLECTOR LEAKAGE CURRENT



DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 19A. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 19 was calculated for various duty cycles.

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 19 by the steady state value $R_{\theta JA}$. Example:

The MPS3905 is dissipating 2.0 watts peak under the following conditions:

t1 = 1.0 ms, t2 = 5.0 ms (D = 0.2)

Using Figure 19 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

The peak rise in junction temperature is therefore

 ΔT = r(t) x P_(pk) x R_θJA = 0.22 x 2.0 x 200 = 88°C. For more information, see AN-569.

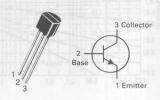
WAXINGWI HATINGO				
Rating	Symbol	2N5088	2N5089	Unit
Collector-Emitter Voltage	VCEO	30	25	Vdc
Collector-Base Voltage	VCBO	35	30	Vdc
Emitter-Base Voltage	VEBO	3	.0	Vdc
Collector Current — Continuous	Ic	50		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	- 55 to	-55 to +150	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	200	°C/W
Thermal Resistance, Junction to Case	R_{θ} JC	83.3	°C/W

2N5088 2N5089

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPSA18 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS			3005	at	
Collector-Emitter Breakdown Voltage(2) (I _C = 1.0 mAdc, I _B = 0)	2N5088 2N5089	V(BR)CEO	30 25		Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc, I_E = 0$)	2N5088 2N5089	V(BR)CBO	35 30	HIL	Vdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) (V _{CB} = 15 Vdc, I _E = 0)	2N5088 2N5089	ICBO	11 4 1	50 50	nAdd
Emitter Cutoff Current (VEB(off) = 3.0 Vdc, I _C = 0) (VEB(off) = 4.5 Vdc, I _C = 0)		I _{EBO}	3-RGT 21 5.100-	50 100	nAdd

DC Current Gain hFE 2N5088 $(I_C = 100 \, \mu Adc, V_{CE} = 5.0 \, Vdc)$ 300 900 2N5089 1200 or pulses can be represented by 400 $(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$ 2N5088 350 2N5089 450 $(I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})(2)$ 2N5088 300 2N5089 400 Collector-Emitter Saturation Voltage VCE(sat) 0.5 $(I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc})$ Base-Emitter On Voltage Vdc VBE(on) $(I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})(2)$

SMALL-SIGNAL CHARACTERISTICS

Current-Gain — Bandwidth Product (I _C = 500 μAdc, V _{CE} = 5.0 Vdc, f = 20 MHz)		OF THE SHIP AR	50	<u>a.</u> 08	MHz
Collector-Base Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	For	C _{cb}	-	4.0	pF
Emitter-Base Capacitance (VEB = 0.5 Vdc, I _C = 0 , f = 1.0 MHz)		C _{eb}	-	10	pF
Small-Signal Current Gain (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N5088 2N5089	h _{fe}	350 450	1400 1800	-
Noise Figure (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k ohms, f = 1.0 kHz)	2N5088 2N5089	NF	=	3.0 2.0	dB

⁽¹⁾ $R_{ heta JA}$ is measured with the device soldered into a typical printed circuit board.

⁽²⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

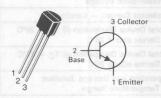
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	50	Vdc
Collector-Base Voltage	VCBO	50	Vdc
Emitter-Base Voltage	VEBO	4.0	Vdc
Collector Current — Continuous	lc	50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	0° 56 €

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

2N5209 2N5210

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPSA18 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	2145400	V(BR)CEO	50	mittin <u>. B</u> reakt mAde, Ig =	Vdc
Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0)	1040/15	V(BR)CBO	50	nbasakdos	Vdc
Collector Cutoff Current (V _{CB} = 35 Vdc, I _E = 0)	21/5401	Ісво	- "	50	nAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0)		IEBO	aganus	50	nAdc
ON CHARACTERISTICS	noasue		70	et all abit 60	West = 1
DC Current Gain (IC = 100 μ Adc, VCE = 5.0 Vdc)	2N5209 2N5210	hFE	100 200	300 600	(VcB =
$(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$	2N5209 2N5210		150 250	off Curront O Valc (C.E. OTENISTICS	MICHARA (VEB = 1 IN CHARA
$(I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})(1)$	2N5209 2N5210		150 250	— nień 35V u bAm	inemus 3. 0.1 = 3.0
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	2NS401	VCE(sat)		0.7	Vdc
Base-Emitter On Voltage (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc)	2ME461-	VBE(on)	1001 0.0	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS	2N9400		5.0 Vde)	= BOV JobAm	08 = 30
Current-Gain — Bandwidth Product (IC = 500 μ Adc, VCE = 5.0 Vdc, f = 20 MHz)	Tosses	fT	30 egetloV not	niter Satura	MHz
Collector-Base Capacitance ($V_{CB} = 5.0 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)		C _{cb}	(abAra 0.)	4.0	pF
Small-Signal Current Gain (IC = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N5209 2N5210	h _{fe}	150 250	600 900	(lc = 50
Noise Figure (I _C = 20 μ Adc, V _{CE} = 5.0 Vdc, R _S = 22 k ohms, f = 1.0 kHz)	2N5209 2N5210	NF (SHM OGT)	in Prevention 10 Value 1	3.0 2.0	dB
(I _C = 20 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k ohms, f = 1.0 kHz)	2N5209 2N5210			4.0 3.0	qii Diliggul

(1) Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

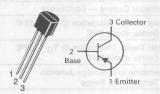
Rating	Symbol	2N5400	2N5401	Unit
Collector-Emitter Voltage	VCEO	120	150	Vdc
Collector-Base Voltage	VCBO	130	160	Vdc
Emitter-Base Voltage	VEBO	aby 5	.0 0.4	Vdc
Collector Current — Continuous	Ic	6	00	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD		25 .0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD		.5 2.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	0−55 to	o +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

2N5400 2N5401*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

★This is a Motorola designated preferred device.

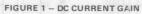
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

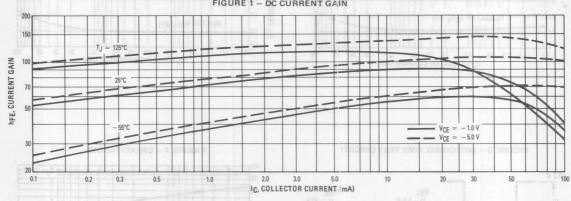
stau xaM niM C	haracteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					CTENETICS	
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	(1) _{DED(RS)} V	2N5400 2N5401	V(BR)CEO	120 150	Macril Turnin	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \ \mu Adc, I_E = 0$)	080	2N5400 2N5401	V(BR)CBO	130 160	an Adc, 1g = 100 Arc	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)	083		V _{(BR)EBO}	5.0	teering th	Vdc
Collector Cutoff Current (V _{CB} = 100 Vdc, I _E = 0) (V _{CB} = 120 Vdc, I _E = 0) (V _{CB} = 100 Vdc, I _E = 0, T _A = 100 (V _{CB} = 120 Vdc, I _E = 0, T _A = 100		2N5400 2N5401 2N5400 2N5401	ІСВО	- 5,0±(dc)	100 50 100 50	nAdc μAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0)		20,62,09	I _{EBO}	6,0 Vdct	50	nAdc
ON CHARACTERISTICS(1)		WY SANIE				THE THE
DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc)		2N5400	hFE	30	BOV abA	01 20
ohV F.0 —		2N5401		50	nitter Setteral Ade. Ig =	3-10toalle 101 = 50
$(I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$		2N5400 2N5401		40 60	180 240	urian3-azu U. t. = gl)
$(I_C = 50 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$		2N5400 2N5401		40 50	ARAHO JAN	MALL-SIC
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc)	45 ⁰		VCE(sat)	= 5.0 Vdc, f	0.20 0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}$, $I_B = 1.0 \text{ mAdc}$) ($I_C = 50 \text{ mAdc}$, $I_B = 5.0 \text{ mAdc}$)	el ^(f)	ZN520\$	V _{BE} (sat)	in = 5,0 <u>V</u> ds, 1	1.0 1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS	314					
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f =	100 MHz)	2N5400 2N5401	= 22 Thins	100 100	400 300	MHz
Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MH	lz)	2N6269 2N6210	C _{obo}	8.0 V <u>a</u> o, Rg	6.0	pF

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
Small-Signal Current Gain	_bs g	h _{fe}			A. 45 - FL
$(I_C = 1.0 \text{ mAdc}, V_{CF} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$	2N5400		30	200	
	2N5401		40	200	
Noise Figure	-10 5	NF		8.0	dB
$(I_C = 250 \mu Adc, V_{CF} = 5.0 Vdc,$				LINIE I	
RS = 1.0 kohm, f = 1.0 kHz)				MILITER	

(1) Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.





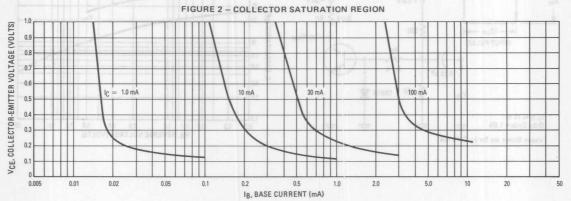
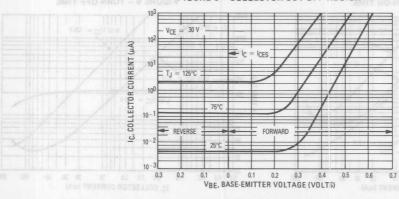
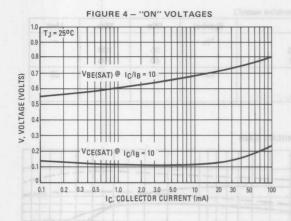
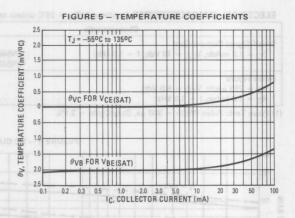
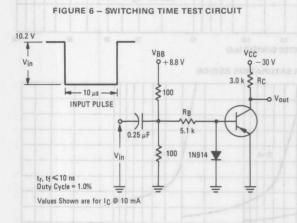


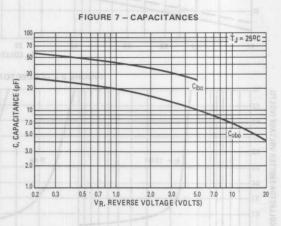
FIGURE 3 - COLLECTOR CUT-OFF REGION

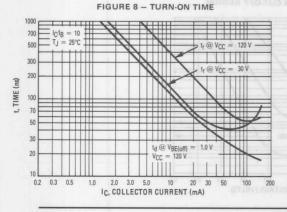


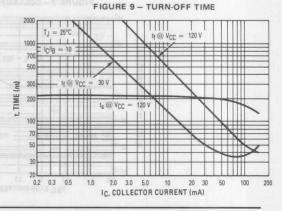












Rating	Symbol	2N5550	2N5551	Unit
Collector-Emitter Voltage	VCEO	140	160	Vdc
Collector-Base Voltage	VCBO	160	180	Vdc
Emitter-Base Voltage	VEBO	6	.0	Vdc
Collector Current — Continuous	Ic	6	00	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD		25 .0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	- 55 to	o +150	°C

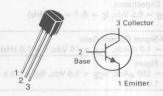
THERMAL CHARACTERISTICS

THE THAT OF A THOU			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W

Characteristic

2N5550 2N5551*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

★This is a Motorola
designated preferred device.

Symbol

ELECTRICAL CHARACTERISTICS	$(T_{\Delta} =$	25°C unless	otherwise	noted.)
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Ollaracteristic		Oymboi	141111	IVIGA	Oilit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0)	2N5550 2N5551	V(BR)CEO	140 160	078	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \ \mu Adc, I_E = 0$)	2N5550 2N5551	V(BR)CBO	160 180		Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)		V(BR)EBO	6.0		Vdc
Collector Cutoff Current (VCB = 100 Vdc, IE = 0) (VCB = 120 Vdc, IE = 0) (VCB = 100 Vdc, IE = 0, TA = 100°C) (VCB = 120 Vdc, IE = 0, TA = 100°C)	2N5550 2N5551 2N5550 2N5551	СВО	3.0 _ 8	100 50 100 50	nAdc μAdc
Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0)		IEBO	-	50	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc)	2N5550 2N5551	hFE O - S BRUDIA	60 80	Ξ	
$(I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$	2N5550 2N5551	1 /1111	60 80	250 250	
$(I_C = 50 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$	2N5550 2N5551		20 30	=	1
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	Both Types	VCE(sat)		0.15	Vdc
(I _C = 50 mAdc, I _B = 5.0 mAdc)	2N5550 2N5551			0.25 0.20	
Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	Both Types	V _{BE} (sat)		1.0	Vdc
(I _C = 50 mAdc, I _B = 5.0 mAdc)	2N5550 2N5551			1.2	

(1) Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

2N5550 2N5551

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					RATINGS	MUNICAT
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	dieno nega	sivesso zi	f _T	100	300	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		160	C _{obo}	-	6.0	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	2N5550 2N5551	0.8 008	C _{ibo}	Epoph	30 20	pF
Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	OP/Wm	0.8	hfe	50	200	December and v
Noise Figure $(I_C = 250 \ \mu Adc, V_{CE} = 5.0 \ Vdc, R_S = 1.0 \ k \ ohm, f = 1.0 \ kHz)$	2N5550 2N5551	12 - 55 to +	NF	nolton	10 8.0	v sds dB

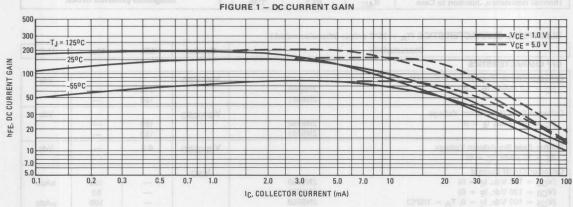
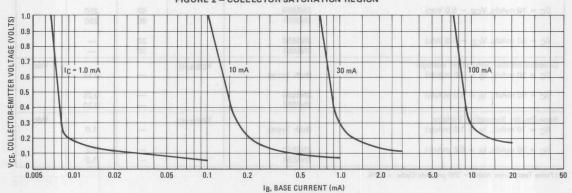
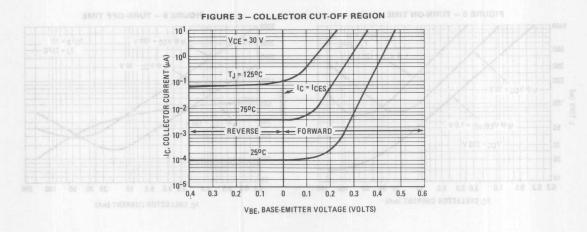
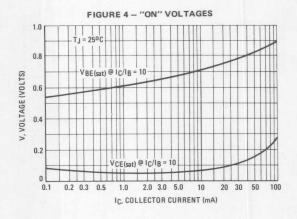
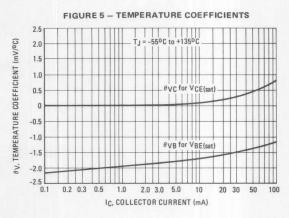


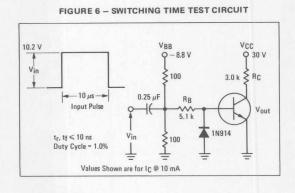
FIGURE 2 - COLLECTOR SATURATION REGION

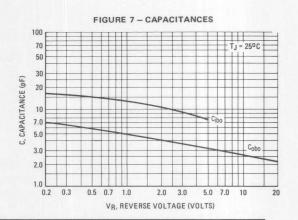




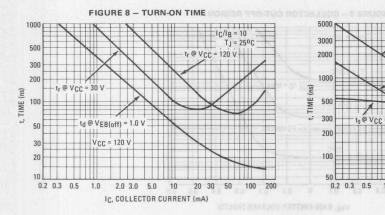


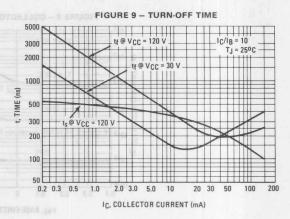


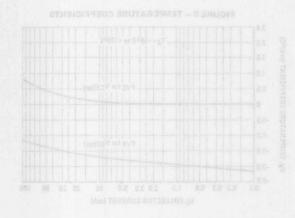


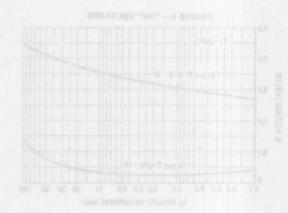


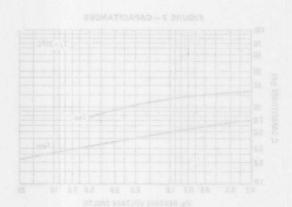
2N5550 2N5551

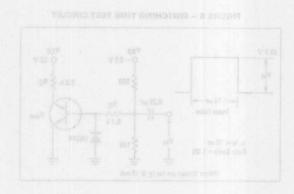












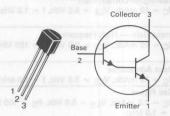
Rating	Symbol	Value	Unit	
Collector-Emitter Voltage	VCEO	40	Vdc	
Collector-Base Voltage	VCBO	40	Vdc	
Emitter-Base Voltage	VEBO	12	Vdc	
Collector Current — Continuous	IC	500	mAdc	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C	
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C	
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W



CASE 29-04, STYLE 1 TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

NPN SILICON

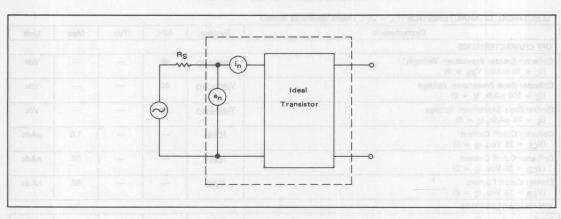
★This is a Motorola designated preferred device.

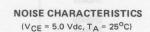
Characteristic	and the last market managers	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, VBE = 0)		V(BR)CEO	40	-	_	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc$, $I_E = 0$)	legal	V _(BR) CBO	40	-		Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	TOTOLOGICAL	V _{(BR)EBO}	12	-	-	Vdc
Collector Cutoff Current (V _{CE} = 25 Vdc, I _B = 0)		ICES	-	_	1.0	μAdd
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0)		ІСВО	_	_	50	nAdd
Emitter Cutoff Current (V _{EB} = 10 Vdc, I _C = 0)		IEBO	_	_	50	nAdd
ON CHARACTERISTICS				Imerally V		
DC Current Gain (1) (I _C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N6426 2N6427	hFE	20,000 10,000	=	200,000	_
$(I_C = 100 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$	2N6426 2N6427	NOA!	30,000 20,000	=	300,000 200,000	
$(I_C = 500 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$	2N6426 2N6427		20,000 14,000	e z <u>–</u> won	200,000 140,000	
Collector-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 0.5 mAdc) (I _C = 500 mAdc, I _B = 0.5 mAdc)	0.9	VCE(sat)	DAVORAN :	0.71 0.9	1.2 1.5	Vdc
Base-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 0.5 mAdc)		V _{BE} (sat)		1.52	2.0	Vdc
Base-Emitter On Voltage (I _C = 50 mAdc, V _{CE} = 5.0 Vdc)		V _{BE(on)}		1.24	1.75	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}	-	5.4	7.0	pF
Input Capacitance (VEB = 1.0 Vdc, I _C = 0, f = 1.0 MHz)	IIImi III	C _{ibo}		10	15	pF

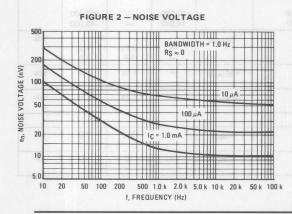
Vital dutolistic			әутроі	iviin	гур	Max	Unit
Input Impedance (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz)	2N	6426	h _{ie}	100	_ 81	2000	kΩ
CASE 28-04, 51 YEE 1	2N	6427	Vetro	50	- 20	1000	S-respalle
Small-Signal Current Gain (IC = 10 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)		6426 6427	h _{fe}	20,000	=	e Volluge	Bao lus llo e6 settim
Current Gain — High Frequency (IC = 10 mAdc, VCE = 5.0 Vdc, f = 100 MHz)		6426 6427	hfe	1.5 1.3	2.4 2.4		otal Device Derete to
Output Admittance (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz)	atrow 34Wha	1.5 12	h _{oe}	26°C—	- 5 1 3 n	1000	μmhos
Noise Figure (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc, R_S = 100 k Ω , f = 1.0 kHz)	2	667 + 61-88	NF	-	3.0	10	an dB q

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 - TRANSISTOR NOISE MODEL







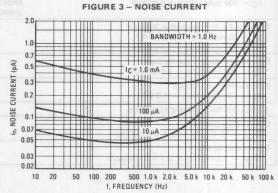


FIGURE 4 - TOTAL WIDEBAND NOISE VOLTAGE

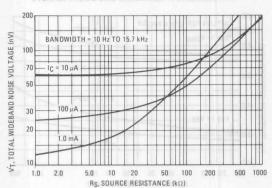
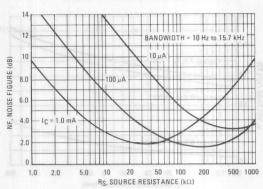


FIGURE 5 - WIDEBAND NOISE FIGURE



SMALL-SIGNAL CHARACTERISTICS

FIGURE 6 - CAPACITANCE

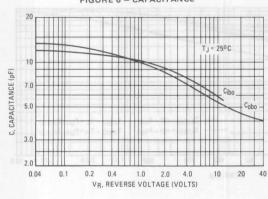


FIGURE 7 - HIGH FREQUENCY CURRENT GAIN

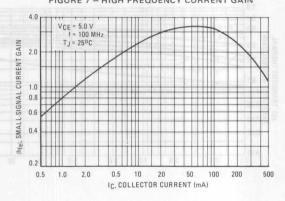


FIGURE 8 - DC CURRENT GAIN

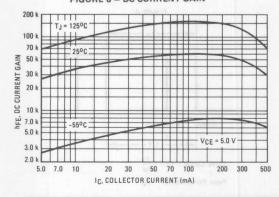


FIGURE 9 - COLLECTOR SATURATION REGION

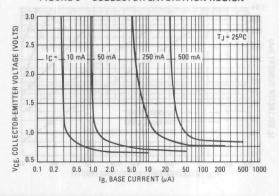


FIGURE 10 - "ON" VOLTAGES

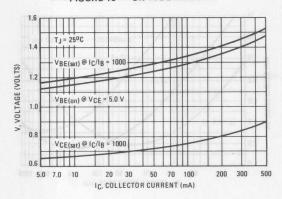


FIGURE 11 - TEMPERATURE COEFFICIENTS

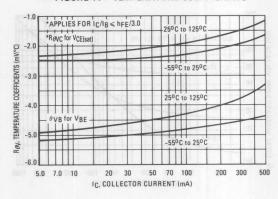


FIGURE 12 - THERMAL RESPONSE

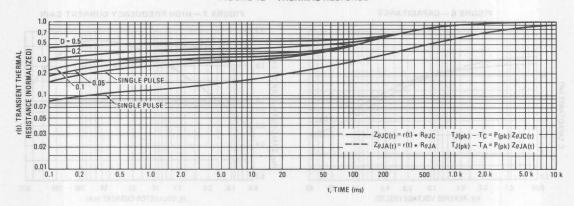
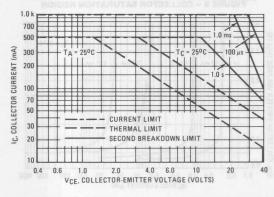
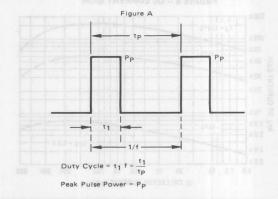


FIGURE 13 - ACTIVE REGION SAFE OPERATING AREA



DESIGN NOTE: USE OF TRANSIENT THERMAL RESISTANCE DATA



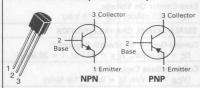
Rating	Symbol	2N6515	2N6516 2N6519	2N6517 2N6520	Unit		
Collector-Emitter Voltage	VCEO	250	300	350	Vdc		
Collector-Base Voltage	ССВО	250	300	350	Vdc		
Emitter-Base Voltage 2N6515, 2N6516, 2N6517 2N6519, 2N6520	V _{EBO}		Vdc				
Base Current	IB		5.0 250		250		mAdc
Collector Current — Continuous	Ic		500	500			
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD				mW/°C		
Total Device Dissipation @T _C = 25°C Derate above 25°C	PD		1.5 12		Watts mW/°C		
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-	-55 to +150		°C		

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	ReJC	83.3	°C/W

2N6515 thru 2N6517* 2N6519(2) 2N6520*(2)

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

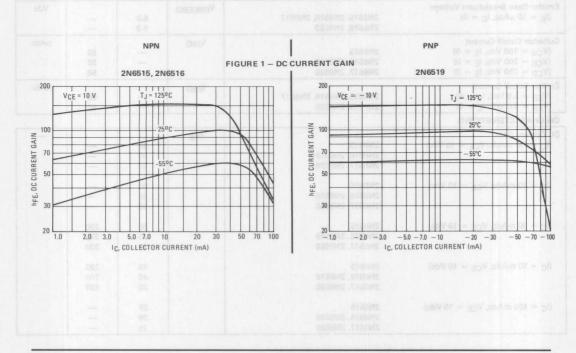
Characteristic		Symbol	Min	Max	Unit	
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) $(I_C = 1.0 \text{ mAdc}, I_B = 0)$	2N6515 2N6516, 2N6519 2N6517, 2N6520	V(BR)CEO	250 300 350	Sent Waller	Vdc	
Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0)	2N6515 2N6516, 2N6519 2N6517, 2N6520	V(BR)CBO	250 300 350		Vdc	
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)	2N6515, 2N6516, 2N6517 2N6519, 2N6520	V _{(BR)EBO}	6.0 5.0	=	Vdc	
Collector Cutoff Current $(V_{CB} = 150 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = 200 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = 250 \text{ Vdc}, I_{E} = 0)$	2N6515 2N6516, 2N6519 2N6517, 2N6520	ICBO	NRW	50 50 50	nAdc	
Emitter Cutoff Current (VEB = 5.0 Vdc, I _C = 0) (VEB = 4.0 Vdc, I _C = 0)	2N6515, 2N6516, 2N6517 2N6519, 2N6520	IEBO	es - <u>1</u>	50 50	nAdc	
ON CHARACTERISTICS(1)						
DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc)	2N6515 2N6516, 2N6519 2N6517, 2N6520	hFE	35 30 20	=	ST TO THE SECOND	
(I _C = 10 mAdc, V _{CE} = 10 Vdc)	2N6515 2N6516, 2N6519 2N6517, 2N6520		50 45 30		- 100 ANA	
(I _C = 30 mAdc, V _{CE} = 10 Vdc)	2N6515 2N6516, 2N6519 2N6517, 2N6520	GE OS (Am) TREPAL	50 45 30	300 270 200	0.7	
$(I_C = 50 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$	2N6515 2N6516, 2N6519 2N6517, 2N6520		45 40 20	220 200 200		
($I_C = 100 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$)	2N6515 2N6516, 2N6519 2N6517, 2N6520		25 20 15	=		

NPN 2N6515 thru 2N6517 PNP 2N6519 2N6520

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

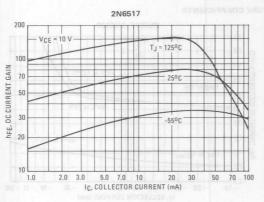
Characteristi	С		Symbol	Min	Max	Unit
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 20 mAdc, I _B = 2.0 mAdc) (I _C = 30 mAdc, I _B = 3.0 mAdc)	36/4/	8.0 5.0 250	VCE(sat)	<	0.30 0.35 0.50	Vdc
(I _C = 50 mAdc, I _B = 5.0 mAdc)	nbAm		1 11		1.0	
Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 20 mAdc, I _B = 2.0 mAdc) (I _C = 30 mAdc, I _B = 3.0 mAdc)			VBE(sat)	apoun	0.75 0.85 0.90	Vdc
Base-Emitter On Voltage (I _C = 100 mAdc, V _{CE} = 10 Vdc)	grasW CrtWm	75.1	V _{BE(on)}	-	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					ve 25°C	Derete abo
Current-Gain — Bandwidth Product(1) (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 20 MHz)	2	1081 + or 88-	efT 4	40	200	MHz
Collector-Base Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 1.0 MHz)	- Paris	201	C _{cb}	a or ren	6.0	pF
Emitter-Base Capacitance ($V_{EB} = 0.5 \text{ Vdc}, I_{C} = 0, f = 1.0 \text{ MHz}$)	2N6515 thru 2 2N6519, 2N65		C _{eb}	con to Ambi	80 100	pF
SWITCHING CHARACTERISTICS						
Turn-On Time $(V_{CC} = 100 \text{ Vdc}, V_{BE(off)} = 2.0 \text{ Vdc}, I_{C} = 50$	mAdc, I _{B1} = 10	0 mAdc)	ton	ERISTICS	200	μs
Turn-Off Time (V _{CC} = 100 Vdc, I _C = 50 mAdc, I _{B1} = I _{B2} =	10 mAdc)		toff	No.	3.5	μs

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (2) Voltage and current are negative for PNP transistors.



NPN 2N6515 thru 2N6517 PNP 2N6519 2N6520

FIGURE 2 - DC CURRENT GAIN



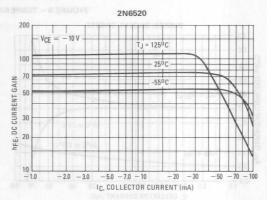
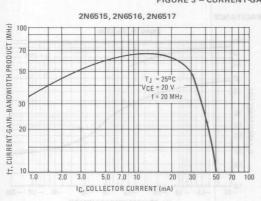
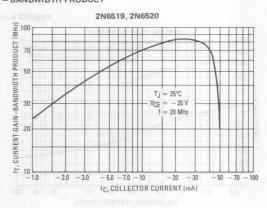


FIGURE 3 – CURRENT-GAIN – BANDWIDTH PRODUCT





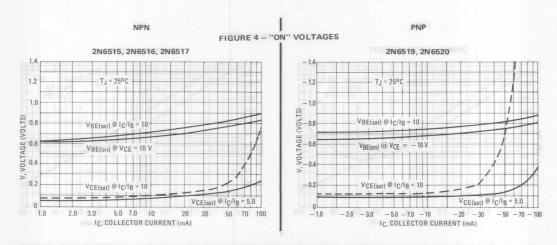
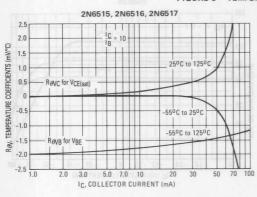
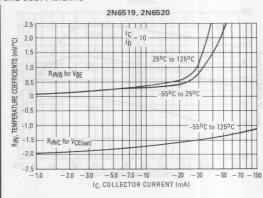
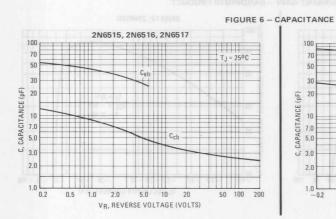
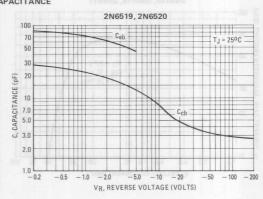


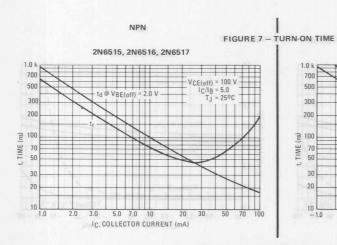
FIGURE 5 - TEMPERATURE COEFFICIENTS

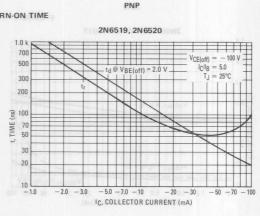






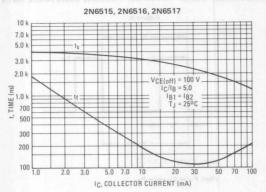






NPN 2N6515 thru 2N6517 PNP 2N6519 2N6520





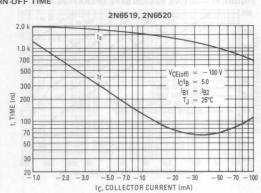
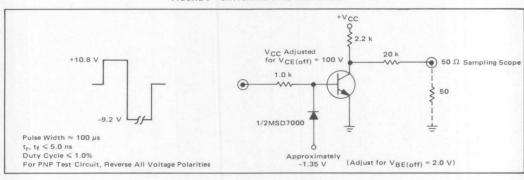
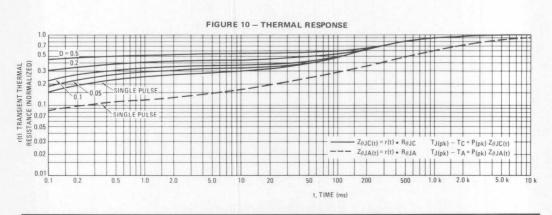


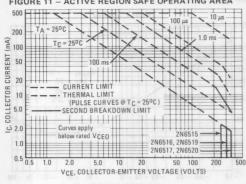
FIGURE 9 - SWITCHING TIME TEST CIRCUIT



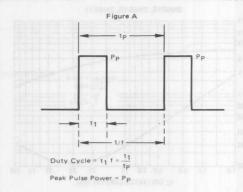


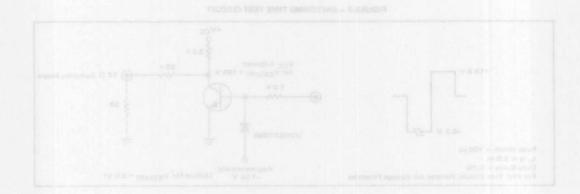
NPN 2N6515 thru 2N6517 PNP 2N6519 2N6520





DESIGN NOTE: USE OF TRANSIENT THERMAL RESISTANCE DATA





Rating	Symbol	-	BC 183	BC 184	Unit
Collector-Emitter Voltage	VCEO	50	30	30	Vdc
Collector-Base Voltage	Vсво	60	45	45	Vdc
Emitter-Base Voltage	VEBO		6.0	5070	Vdc
Collector Current - Continuous	IC		100	Data	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	5	350 2.8	9013	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	p V	1.0 8.0		Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	- 58	to +	-150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	125	°C/W

BC182,A,B BC183 BC184

CASE 29-04, STYLE 17 TO-92 (TO-226AA)

1 Collector

3 Emitter



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to BC237 for graphs.

ELECTRICAL	CHARACTERISTICS	$(T_{\Delta} =$	25°C unless	otherwise noted.)
------------	-----------------	-----------------	-------------	-------------------

Characteristic		#810B	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS							
Collector-Emitter Breakdown Voltag ($I_C = 2.0 \text{ mA}, I_B = 0$)	BC182 BC183 BC184	SC 183 BC 184	V(BR)CEO	50 30 30	=	Ξ	V
Collector-Base Breakdown Voltage (IC = 10 μ A, IE = 0)	BC182 BC183 BC184		V(BR)CBO	60 45 45	Ξ	Ē	V
Emitter-Base Breakdown Voltage (I _E = 100 μ A, I _C = 0)			V(BR)EBO	6.0	-	1 -	V
Collector Cutoff Current (VCB = 50 V, VBE = 0) (VCB = 30 V, VBE = 0)	BC182 BC183 BC184		ICBO	Œ	0.2 0.2 0.2	15 15 15	nA
Emitter-Base Leakage Current (VEB = 4.0 V, I _C = 0)			IEBO	_	-	15	nA
ON CHARACTERISTICS							
DC Current Gain (I _C = 10 μ A, V _{CE} = 5.0 V)	BC182 BC183 BC184		hFE	40 40 100	=	Ξ	
$(I_C = 2.0 \text{ mA, } V_{CE} = 5.0 \text{ V})$	BC182 BC183 BC184			120 120 250	=	500 800 800	
$(I_C = 100 \text{ mA}, V_{CE} = 5.0 \text{ V})$	BC182 BC183 BC184			80 80 130	_	=	
	$C = 10 \text{ mA}, I_B = 0.5 \text{ mA}$ $C = 100 \text{ mA}, I_B = 5.0 \text{ mA}$		VCE(sat)	=	0.07 0.2	0.25 0.6	٧
Base-Emitter Saturation Voltage (I	C = 100 mA, IB = 5.0 mA	*	V _{BE(sat)}	1-1	_	1.2	V
(1)	$C = 100 \mu A$, $V_{CE} = 5.0 V$) $C = 2.0 \text{ mA}$, $V_{CE} = 5.0 V$) $C = 100 \text{ mA}$, $V_{CE} = 5.0 V$)	*	VBE(on)	0.55 —	0.5 0.62 0.83	 0.7 	V

^{*}Pulse Test: Tp 300 s, Duty Cycle 2.0%.

BC182,A,B BC183 BC184

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Тур	Max	Unit
DYNAMIC CHARACTERISTICS		The last			00	WILLIAM CALL	Tral Activity
Current-Gain Bandwidth Product ($I_C = 0.5 \text{ mA}, V_{CE} = 3.0 \text{ V}, f = 100 \text{ MHz}$)		BC182 BC183 BC184	58 fT 58 083	v E	100 120 140	gev Linns	MHz
$(I_C = 10 \text{ mA}, V_{CE} = 5.0 \text{ V}, f = 100 \text{ MHz})$		BC182 BC183 BC184	08	150 150 150	200 240 280	Surface Control	C settin
Common Base Output Capacitance (V _{CB} = 10 V, I _C = 0, f = 1.0 MHz)	2 *1.00m	8.	C _{ob}		A-01-0-0	5.0	pF
Common Base Input Capacitance (VEB = 0.5 V, I _C = 0, f = 1.0 MHz)	Do/White	0.00	C _{ib}		8.0	512 wad	pF
Small-Signal Current Gain (I _C = 2.0 mA, V _{CE} = 5.0 V, f = 1.0 kHz)	siet) voor wid	BC182 BC183 BC184 BC182A BC182B	h _{fe}	125 125 240 125 240	ERISTICS CONTROL CO	500 900 900 260 500	ALARES
Noise Figure (I _C = 0.2 mA, V _{CE} = 5.0 V, R _S = 2.0 k ohms, f = 1.0 kHz)		Lbaton said	NF	0785 - ATI	артакато	AL CHARA	dB
(I _C = 0.2 mA, V_{CE} = 5.0 V, R_{S} = 2.0 k ohms, f = 1.0 kHz, f = 200 Hz)		BC184 BC182		<u> </u>	2.0	4.0	LAND SI
		BC183 BC184		- I	2.0	10 4.0	evolutile C = evil

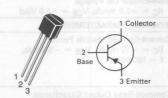
Rating	Symbol	BC 212	BC 213	BC 214	Unit
Collector-Emitter Voltage	VCEO	-50	-30	-30	Vdc
Collector-Base Voltage	VCBO	-60	-45	-45	Vdc
Emitter-Base Voltage	VEBO	V _{EBO} -5.0			Vdc
Collector Current — Continuous	Ic		-100		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	P _D 350 2.8			mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	P _D 1.0 8.0			Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55	to +	150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	R_{θ} JC	125	°C/W

BC212,B BC213 BC214

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

Refer to BC307 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted).

Characteristic	Туре	Symbol	Min	Тур	Max	Unit
Collector-Emitter Breakdown Voltage ($I_C = -2.0 \text{ mAdc}, I_B = 0$)	BC212 BC213 BC214	V(BR)CEO	-50 -30 -30	/CE = ~ E.	2.0 mAde.	Vdc
Collector-Base Breakdown Voltage (IC = $-10 \mu A$, IE = 0)	BC212 BC213 BC214	V(BR)CBO	- 60 - 45 - 45	aliti pitaya-	p 300 m Dura	Vdc
Emitter-Base Breakdown Voltage (IE = $-10~\mu Adc$, IC = 0)	BC212 BC213 BC214	V _{(BR)EBO}	-5 -5 -5	Ξ	=	Vdc
Collector-Emitter Leakage Current (V _{CB} = -30 V)	BC212 BC213 BC214	ІСВО	Ξ	Ξ	- 15 - 15 - 15	nAdc
Emitter-Base Leakage Current (VEB = -4.0 V, I _C = 0)	BC212 BC213 BC214	IEBO	=	Ξ	- 15 - 15 - 15	nAdc
ON CHARACTERISTICS						
DC Current Gain (I _C = $-10~\mu$ Adc, V _{CE} = $-5.0~\text{Vdc}$)	BC212 BC213 BC214	hFE	40 40 100	=	Ξ	
(I _C = -2.0 mAdc, V _{CE} = -5.0 Vdc)	BC212 BC213 BC214		60 80 140	Ξ	600	
$(I_C = -100 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc})*$	BC212, BC214 BC213		=	120 140	=	

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted).

Characteristic		Туре	Symbol	Min	Тур	Max	Unit
Collector-Emitter Saturation Voltage (I _C = -10 mAdc, I _B = -0.5 mAdc) (I _C = -100 mAdc, I _B = -5.0 mAdc)*	abV abv	95 - 95 - 98 - 90 - 46 - 40	V _{CE(sat)}	=	-0.10 -0.25	_ -0.6	Vdc
Base-Emitter Saturation Voltage (IC = -100 mAdc, IB = -5.0 mAdc)	ggV	-6.0	V _{BE} (sat)	-	-1.0	-1.4	Vdc
Base-Emitter On Voltage (I _C = -2.0 mAdc, V _{CE} = -5.0 Vdc)	Vien	350	V _{BE(on)}	-0.6	-0.62	-0.72	Vdc
DYNAMIC CHARACTERISTICS	enelli.	1 02		- Super			um d Jased
Current-Gain Bandwidth Product (IC = -10 mAdc, VCF = -5.0 Vdc,	O⊓Wm	0.0	fτ			Ord Flavord	MHz
f = 100 MHz)	38	BC212 BC214 BC213	BHT SET	=	280 320 360	and Stores	Operating Temper
Common-Base Output Capacitance (V _{CB} = -10 Vdc, I _C = 0, f = 1.0 MHz)	Bint/	Nies	Cob	_	JH FE <u>SH</u> S F. siteho	6.0	pF
Noise Figure	VVO'	385	NF	Jenning A	of politanul	onheteino)	dB
$ \begin{array}{ll} \text{(IC} = -0.2 \text{ mAdc, V}_{\text{CE}} = -5.0 \text{ Vdc,} \\ \text{Rs} = 2.0 \text{ k ohms, f} = 1.0 \text{ kHz)} \\ \text{(IC} = -0.2 \text{ mAdc, V}_{\text{CE}} = -5.0 \text{ Vdc,} \\ \text{Rs} = 2.0 \text{ k ohms, f} = 1.0 \text{ kHz, f} = 200 \text{ Hz)} \\ \end{array} $	Wio	BC214 BC213 BC212	Rate 28°C unlesser	Caso	undion to	2 10 10	Thermal I
Small Signal Current Gain		BCZ1Z	h _{fe}		a produce and	10	
$(I_C = -2.0 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc}, f = 1.0 \text{ kHz})$		BC212 BC213 BC214 BC212B		60 80 140 200	lo < g C < g	400	

^{*} Pulst-test: Tp 300 s, Duty-cycle 2%.

Collector five Breaklown Veltage (Ig = -10 µA, Ig = 0)

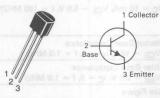
Rating	Symbol	BC 237	BC 238	BC 239	Unit
Collector-Emitter Voltage	VCEO	45	25	25	Vdc
Collector-Emitter Voltage	VCES	50	30	30	Vdc
Emitter-Base Voltage	VEBO	6.0	5.0	5.0	Vdc
Collector Current - Continuous	IC 100			mAdc	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD		350 2.8		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	PD 1.0 8.0			Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-55	to -	F150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	R_{θ} JC	125	°C/W

BC237,A,B,C BC238,B,C BC239,C

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

ELECTRICAL CHARACTERISTICS (TA = 25 °C unless otherwise noted)

Characteristic	Туре	Symbol	Min.	Тур.	Max.	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (IC = 2.0 mA, IB = 0)	BC237 BC238 BC239	V(BR)CEO	45 25 25	NORMALI	. F sausi	V
Emitter-Base Breakdown Voltage (IE = 100 μ A, IC = 0)	BC237 BC238 BC239	V(BR)EBO	6 5 5			V
Collector Cutoff Current (VCE = 30 V, VBE = 0) (VCE = 50 V, VBE = 0)	BC238 BC239 BC237	ICES		0.20 0.20 0.20	15 15 15	nA
(VCE = 30 V, VBE = 0) TA = 125 °C (VCE = 50 V, VBE = 0) TA = 125 °C	BC238 BC239 BC237	/		0.20 0.20 0.20	4 4 4	μΑ

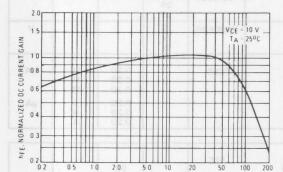
ON CHARACTERISTICS

DC Current Gain (IC = 10 μA, VCE = 5 V)		hFE				
CONTROL OF THE STATE OF THE STA	BC237A BC237B/238B BC237C/238C/239C	100 05 100 Amu	NU ON FRANKUS RU	90 150 270		5.0
(I _C = 2 mA, V _{CE} = 5 V)	BC237 BC238 BC239 BC237A BC237B/238B BC237C/238C/239C	SON HYOW	120 120 120 120 200 380	170 290 500	800 800 800 220 460 800	(6) F1
$(I_C = 100 \text{ mA}, V_{CE} = 5 \text{ V})$	BC237A BC237B/238B BC237C/238C/239C	H		120 180 300		-lous
Collector-Emitter On Voltage (IC = 10 mA, IB = 0.5 mA) (IC = 100 mA, IB = 5 mA)	BC237/BC238/BC239 BC237/BC239 BC238	VCE(sat)		0.07 0.20	0.20 0.60 0.8	V
Base-Emitter Saturation Voltage (IC = 10 mA, I _B = 0.5 mA) (IC = 100 mA, I _B = 5 mA)	05 2	VBE(sat)		0.60	0.83 1.05	V
Base-Emitter On Voltage (IC = 100 μA, VCE = 5 V) (IC = 2 mA, VCE = 5 V) (IC = 100 mA, VCE = 5 V)	E0 30 80 90	VBE(on)	0.55	0.50 0.62 0.83	0.70	OS ED

BC237,A,B,C BC238,B,C BC239,C

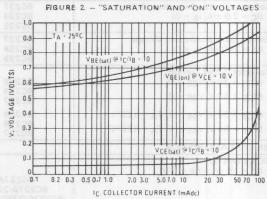
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

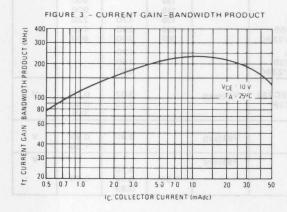
Characteristic	Type		Symbo	1	Min	Тур	Max	Unit
DYNAMIC CHARACTERISTICS	15017	las I	as Las	Total	us T		onitali	
Current-Gain — Bandwidth Product		essis	fT					MHz
(IC = 0.5 mA, VCE = 3.0 V, f = 100 MHz)	BC237		30 FB	700	W-	100	astleiv Tellin	1-votosi
CASE 29-04. STVLE 17	BC238		an last	1	_	120	_	
TO-92 (TO-226AA)	BC239		JE DE	5,40		140	Sellov_Tortin	Bhotasli
			0.0	0,03			e Voltage	itter-Bas
$(I_C = 10 \text{ mA}, V_{CE} = 5.0 \text{ V}, f = 100 \text{ MHZ})$	BC237		01 1	of the	150	200	nent - Con	O rotoel
	BC238		35	1,0	150	240	Total Control of the	roiva d la
	BC239		10.00		150	280	101780-5-110	da otean
Collector-Base Capacitance (V _{CB} = 10 V, I _C = 0, f = 1.0 MHz)			Cobo		-		4.50	pF
			0.0	- 4		Nex = 31 89	TOURS OF STREET	ide overe
Emitter-Base Capacitance	20	oar+	Cibo		_	8.0		pF
$(V_{EB} = 0.5 \text{ V}, I_{C} = 0, f = 1.0 \text{ MHz})$			61 66180	Bis.		HOWGHIE	aparoxe on	desanta
Noise Figure			NF			80/10	and all	dB
(IC = 0.2 mA, VCE = 5.0 V, RS = 2.0 K ohms,						6940191	21.00.1001.	UP-UP-DE
f = 1.0 kHz)	BC239		sld .	louin	48	2.0	4.0	
			35	ALB		sidmA at no	etence, June	eeff Ismu
(I _C = 0.2 mA, V_{CE} = 5.0 V, R_{S} = 2.0 K ohms f = 1.0 kHz, Δf = 200 Hz)				200		eas 3 es not	intance June	end Sec
	BC237		and the	1	-	2.0	10	
	BC238				70.000	2.0	10	Lanna a
	BC239		C mulants	407 =	ALLER	2.0	4.0	11711 (13)

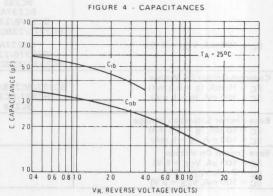


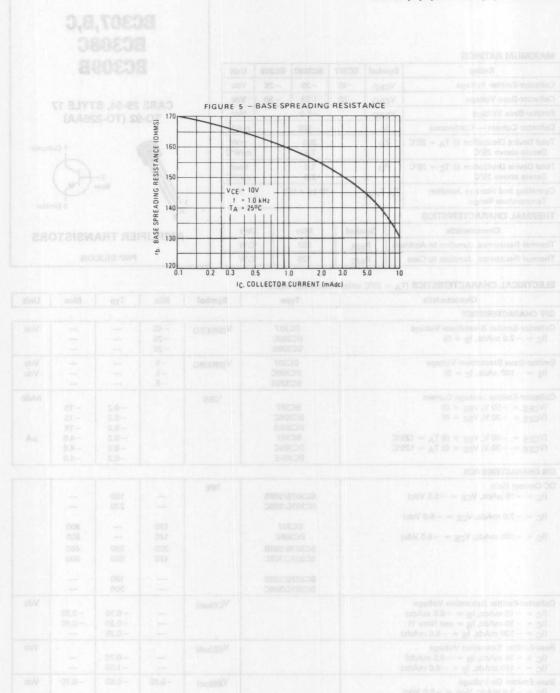
IC. COLLECTOR CURRENT (mAdc)

FIGURE 1 - NORMALIZED DC CURRENT GAIN









Rating	Symbol	BC307	BC308C	BC309	Unit		
Collector-Emitter Voltage	VCEO	-45	- 25	-25	Vdc		
Collector-Base Voltage	VCBO	-50	-30	-30	Vdc		
Emitter-Base Voltage	VEBO		-5.0		Vdc		
Collector Current — Continuous	Ic	-100			-100		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8		1	mW mW/°C		
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0 8.0		Watt mW/°C			
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C			

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	Reic	125	°C/W

BC307,B,C BC308C BC309B

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



Symbol



AMPLIFIER TRANSISTORS

PNP SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic

	1	-1				
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I _C = -2.0 mAdc, I _B = 0)	BC307 BC308C BC309B	V(BR)CEO	-45 -25 -25	=	=	Vdc
Emitter-Base Breakdown Voltage (IE = $-100 \mu Adc$, IC = 0)	BC307 BC308C BC309B	V(BR)EBO	-5 -5 -5	=	Ξ	Vdc Vdc
Collector-Emitter Leakage Current (VCES = -50 V, VBE = 0) (VCES = -30 V, VBE = 0) (VCES = -50 V, VBE = 0) TA = 125°C (VCES = -30 V, VBE = 0) TA = 125°C	BC307 BC308C BC309B BC307 BC308C BC309B	ICES		-0.2 -0.2 -0.2 -0.2 -0.2 -0.2	-15 -15 -15 -4.0 -4.0	nAdc μA
ON CHARACTERISTICS			E Harmar			
DC Current Gain ($I_C=-10~\mu Adc$, $V_{CE}=-5.0~Vdc$) ($I_C=-2.0~m Adc$, $V_{CE}=-5.0~Vdc$) ($I_C=-100~m Adc$, $V_{CE}=-5.0~Vdc$)	BC307B/309B BC307C/308C BC307 BC308C BC307B/309B BC307C/308C BC307B/309B BC307C/308C	hFE	120 120 120 200 420	150 270 ——————————————————————————————————	800 800 460 800	
Collector-Emitter Saturation Voltage ($I_C = -10 \text{ mAdc}$, $I_B = -0.5 \text{ mAdc}$) ($I_C = -10 \text{ mAdc}$, $I_B = \text{see Note 1}$) ($I_C = -100 \text{ mAdc}$, $I_B = -5.0 \text{ mAdc}$)		VCE(sat)	=	-0.10 -0.30 -0.25	-0.30 -0.60	Vdc
Base-Emitter Saturation Voltage ($I_C = -10$ mAdc, $I_B = -0.5$ mAdc) ($I_C = -100$ mAdc, $I_B = -5.0$ mAdc)		V _{BE(sat)}	Ξ	-0.70 -1.00	=	Vdc

Note 1: $I_C = -10$ mAdc on the constant base current characteristic, which yields the point $I_C = -11$ mAdc, $V_{CE} = -1.0$ V

Base-Emitter On Voltage

 $(I_C = -2.0 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc})$

-0.55

VBE(on)

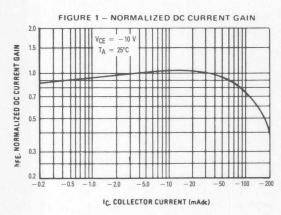
-0.62

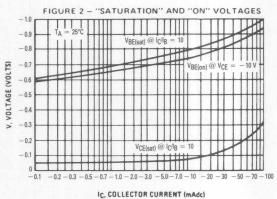
-0.70

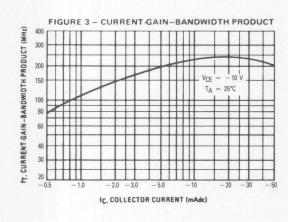
Vdc

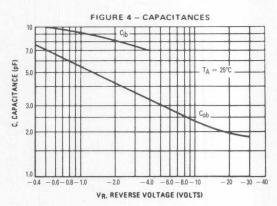
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted)

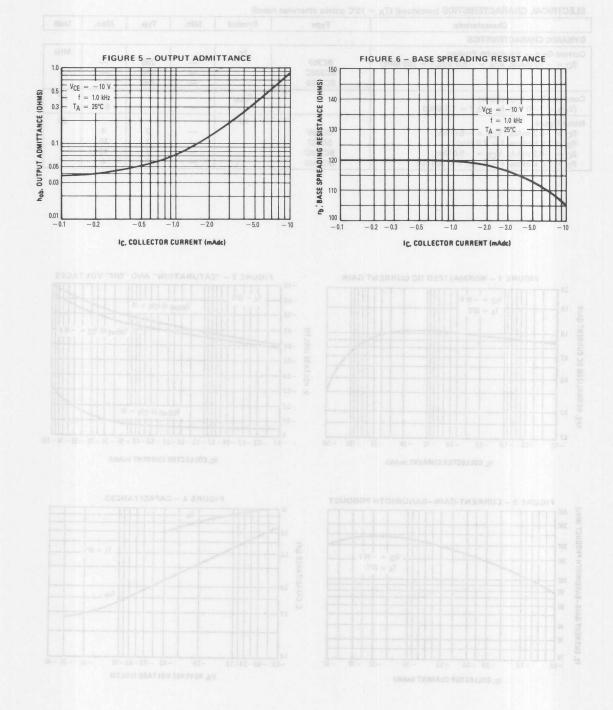
Characteristic	Type	Symbol	Min.	Тур.	Max.	Unit
DYNAMIC CHARACTERISTICS						
Current-Gain — Bandwidth Product (IC = -10 mAdc, VCE = -5.0 Vdc, f = 100 MHz)	BC307 BC308C BC309B	fT	MAGA_TUR	280 320 360	nuar <u>ı</u>	MHz
Common-Base Capacitance (V _{CB} = -10 Vdc, I _C = 0, f = 1.0 MHz)	- w & -	C _{cbo}			6.0	pF
Noise Figure (I _C = -0.2 mAdc, V _{CE} = -5.0 Vdc, R _S = 2.0 k ohms, f = 1.0 kHz) (I _C = -0.2 mAdc, V _{CE} = -5.0 Vdc, R _S = 2.0 k ohms, f = 1 kHz, f = 200 Hz)	BC309 BC307 BC308C BC309B	NF	=	2 2 2 2	4 10 10	dB











MAXIMOW HATINGO							
Rating	Symbol	BC327	BC328	Unit			
Collector-Emitter Voltage	VCEO	-45	-25	Vdc			
Collector-Base Voltage	Vсво	-50	-30	Vdc			
Emitter-Base Voltage	VEBO	-5.0		Vdc			
Collector Current — Continuous	Ic	-800		mAdc			
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C			
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watt mW/°C			
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C			

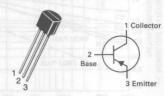
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	RAIC	83.3	°C/W

BC327,-16,-25 BC328,-16,-25

0327,-16,-25 BC328,-16,-25

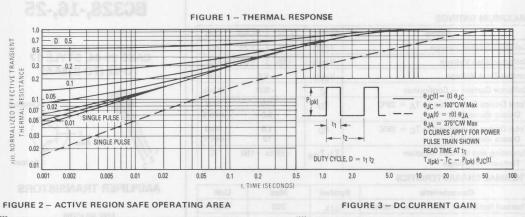
CASE 29-04, STYLE 17 TO-92 (TO-226AA)

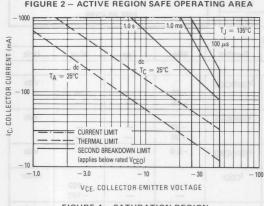


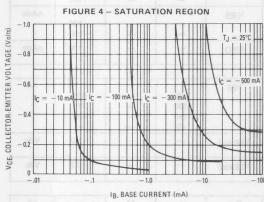
AMPLIFIER TRANSISTORS

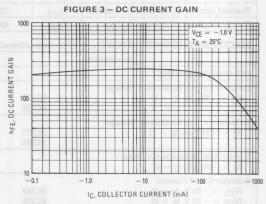
PNP SILICON

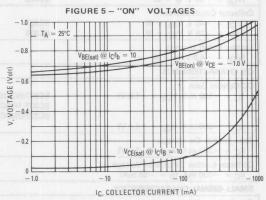
Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS		111111	1- 285	- J. K.	112%	
Collector-Emitter Breakdown Voltage (IC = -10 mA, I _B = 0)	BC327 BC328	V(BR)CEO	- 45 - 25			Vdc
Collector-Emitter Breakdown Voltage ($I_C = -100 \mu A$, $I_E = 0$)	BC327 BC328	V(BR)CES	-50 -30		1738AJ	Vdc
Emitter-Base Breakdown Voltage (IE = $-10 \mu A$, IC = 0)		V _{(BR)EBO}	-5.0	Timul <u>Marcola st</u> logg ^y kella wa	e dangers of makings	Vdc
Collector Cutoff Current $(V_{CB} = -30 \text{ V}, I_E = 0)$ $(V_{CB} = -20 \text{ V}, I_E = 0)$	BC327 BC328	ІСВО	95 AT TO V 931	1903 (40) 5313	- 100 - 100	nAdo
Collector Cutoff Current (VCE = -45 V, VBE = 0) (VCE = -25 V, VBE = 0)	BC327 BC328	ICES	DIDIS NOI	- SATURAY	- 100 - 100	nAdo
Emitter Cutoff Current (VEB = -4.0 V, I _C = 0)		IEBO	1		-100	nAdd
ON CHARACTERISTICS						
DC Current Gain $(I_C = -100 \text{ mA, V}_{CE} = -1.0 \text{ V})$ $(I_C = -300 \text{ mA, V}_{CE} = -1.0 \text{ V})$	BC327/BC328 BC327-16/BC328-16 BC327-25/BC328-25	hFE	100 100 160 40	1 = nor-	630 250 400	7 2 8.0
Base-Emitter On Voltage $(I_C = -300 \text{ mA}, V_{CE} = -1.0 \text{ V})$		V _{BE(on)}			-1.2	Vdc
Collector-Emitter Saturation Voltage (I _C = -500 mA, I _B = -50 mA)		VCE(sat)		MHH	-0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS			- (5m) Tit 10	rain name a		
Output Capacitance (V _{CB} = -10 V, I _E = 0, f = 1.0 MHz)		C _{ob}	-	11	-	pF
Current-Gain — Bandwidth Product (I _C = -10 mA, V _{CE} = -5.0 V, f = 100 MHz		fT	-	260	-	MHz

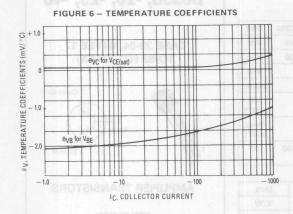


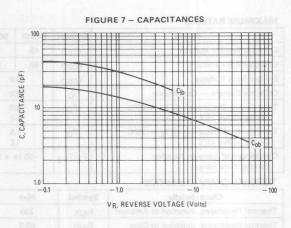












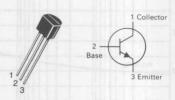
Rating	Symbol	BC337	BC338	Unit
Collector-Emitter Voltage	VCEO	45	25	Vdc
Collector-Base Voltage	VCBO	50	30	Vdc
Emitter-Base Voltage	VEBO	5.0		Vdc
Collector Current — Continuous	Ic	800		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

BC337, -16, -25, -40 BC338, -16, -25, -40

CASE 29-04, STYLE 17 TO-92 (TO-226AA)

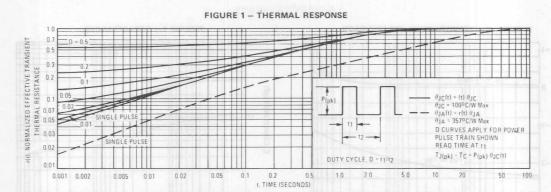


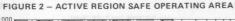
AMPLIFIER TRANSISTORS

NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I _C = 10 mA, I _B = 0)	BC337 BC338	V(BR)CEO	45 25	=		Vdc
Collector-Emitter Breakdown Voltage (I _C = 100 μ A, I _E = 0)	BC337 BC338	V(BR)CES	50 30	_	=	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ A, I _C = 0)		V _{(BR)EBO}	5.0	-	-	Vdc
Collector Cutoff Current (V _{CB} = 30 V, I _E = 0) (V _{CB} = 20 V, I _E = 0)	BC337 BC338	ICBO		=	100 100	nAdc
Collector Cutoff Current (V _{CE} = 45 V, V _{BE} = 0) (V _{CE} = 25 V, V _{BE} = 0)	BC337 BC338	ICES	Ξ	_	100 100	nAdc
Emitter Cutoff Current (V _{EB} = 4.0 V, I _C = 0)		IEBO	-	_	100	nAdc
ON CHARACTERISTICS						
DC Current Gain ($I_C = 100$ mA, $V_{CE} = 1.0$ V) ($I_C = 300$ mA, $V_{CE} = 1.0$ V)	BC337/BC338 BC337-16/BC338-16 BC337-25/BC338-25 BC337-40/BC338-40	hFE	100 100 160 250 60	= = =	630 250 400 630	
Base-Emitter On Voltage (I _C = 300 mA, V _{CE} = 1.0 V)		V _{BE} (on)	_	_	1.2	Vdc
Collector-Emitter Saturation Voltage (I _C = 500 mA, I _B = 50 mA)		V _{CE(sat)}	_	_	0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Output Capacitance (V _{CB} = 10 V, I _E = 0, f = 1.0 MHz)		C _{ob}	-	15		pF
Current-Gain Bandwidth Product (I _C = 10 mA, V _{CE} = 5.0 V, f = 100 MHz)		fT	-	210		MHz





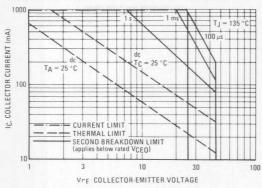


FIGURE 4 - SATURATION REGION

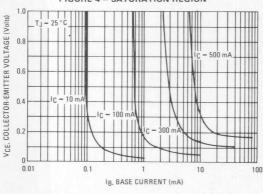


FIGURE 3 - DC CURRENT GAIN

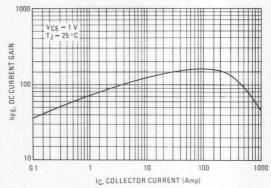
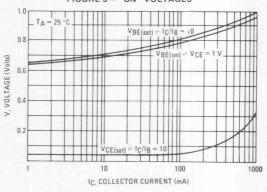
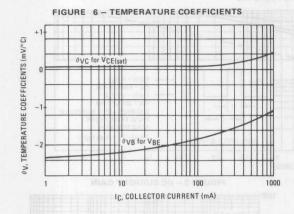
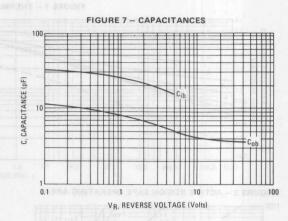
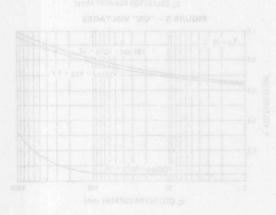


FIGURE 5 - "ON" VOLTAGES









Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	20	Vdc
Collector-Emitter Voltage	VCES	25	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current - Continuous	IC	1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W





PNP BC369⁽¹⁾



CASE 29-04, STYLE 14 TO-92 (TO-226AA)

AMPLIFIER TRANSISTORS

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

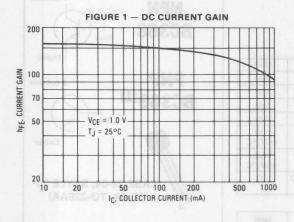
Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS				Diskut	
Collector-Emitter Breakdown Voltage (I _C = 10 mA, I _B = 0)	V(BR)CEO	20	- 1 - 1 1 = 3	ox 3 Moraga	Vdc
Collector-Base Breakdown Voltage (I _C = 100 µA, I _E = 0)	V(BR)CBO	25			Vdc
Emitter-Base Breakdown Voltage (I _E = 100 µA, I _C = 0)	V(BR)EBO	5.0			Vdc
Collector Cutoff Current (V _{CB} = 25 V, I _E = 0) (V _{CB} = 25 V, I _E = 0, T _J = 150°C)	СВО		HI	10 1.0	μAdc mAdc
Emitter Cutoff Current (VEB = 5.0 V, IC = 0)	IEBO	(ATEL DATE)	US RUTGBLING	10	μAdc

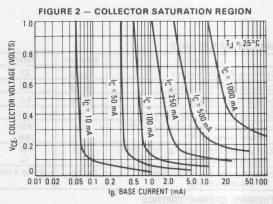
ON CHARACTERISTICS

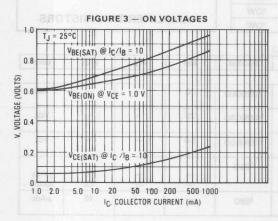
DC Current Gain (VCE = 10 V, IC = 5.0 mA)	hFE	50	ENT GAIN-B	6 - CURR	3RUETR
(V _{CE} = 1.0 V, I _C = 0.5 A) (V _{CE} = 1.0 V, I _C = 1.0 A)		85 60		375 —	
Bandwidth Product (I _C = 10 mA, V _{CE} = 5.0 V, f = 20 MHz)	fT	65			MHz
Collector-Emitter Saturation Voltage (I _C = 1.0 A, I _B = 100 mA)	V _{CE(sat)}	1 1		0.5	V
Base-Emitter On Voltage (I _C = 1.0 A, V _{CE} = 1.0 V)	V _{BE} (on)			1.0	V

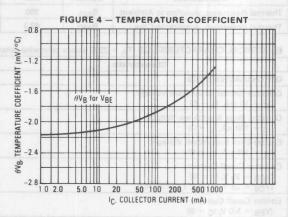
(1) Voltage and current are negative for PNP Transistors.

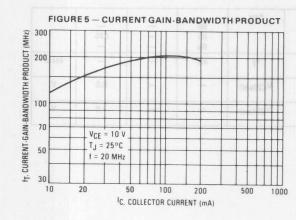
NPN BC368 PNP BC369

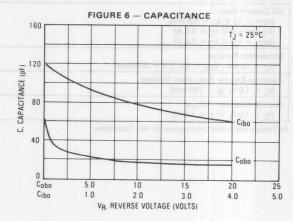












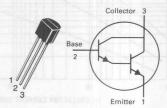
Rating	Symbol	BC372	BC373	Unit
Collector-Emitter Voltage	VCES	100	80	Vdc
Collector-Base Voltage	VCBO	100	80	Vdc
Emitter-Base Voltage	VEBO	8.0 %	2	Vdc
Collector Current — Continuous	lc	1.0		Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD		.5	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to	+ 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	RAIC	83.3	°C/W

BC372 BC373

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



HIGH VOLTAGE DARLINGTON TRANSISTORS

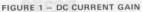
NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteris	tic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS		144					
Collector-Emitter Breakdown Voltage* (IC = 100 μ Adc, IB = 0)	BC372 BC373		V(BR)CES	100 80		1	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	BC372 BC373		V(BR)CBO	100 80		=	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)			V(BR)EBO	12			Vdc
Collector Cutoff Current (VCB = 80 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0)	BC372 BC373	etta	ІСВО	nice de la composi		100 100	nAdc
Emitter Cutoff Current (V _{EB} = 10 V, I _C = 0)			IEBO			100	nAdc
ON CHARACTERISTICS*							
DC Current Gain (I _C = 250 mAdc, V_{CE} = 5.0 Vdc) (I _C = 100 mAdc, V_{CE} = 5.0 Vdc)			hFE	8.0 10	_	160	К
Collector-Emitter Saturation Voltage (I _C = 250 mAdc, I _B = 0.25 mAdc)			VCE(sat)	-	1.0	1.1	Vdc
Base-Emitter Saturation Voltage (I _C = 250 mAdc, I _B = 0.25 mAdc)			V _{BE} (sat)	S T A	1.4	2.0	Vdc
DYNAMIC CHARACTERISTICS						100	
Current-Gain Bandwidth Product (I _C = 100 mAdc, V _{CE} = 5.0 Vdc, f = 100	MHz)		fT	100	200		MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)			C _{ob}		10	25	pF
Noise Figure (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc, R_{q} = 100) k ohm, f = 1.0 kHz)		NF		2.0	-	dB

^{*}Pulse Test: Pulse Width = 300 μ s, Duty Cycle 2.0%.

BC372 BC373



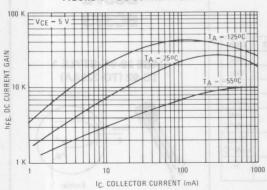


FIGURE 2 - "SATURATION" AND "ON" VOLTAGES

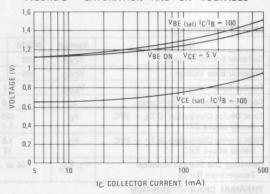


FIGURE 3 - CURRENT GAIN BANDWIDTH PRODUCT

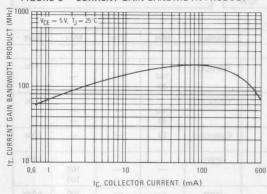
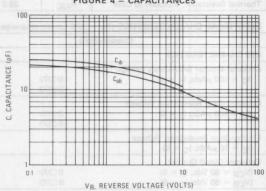


FIGURE 4 - CAPACITANCES



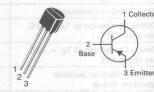
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-100	Vdc
Collector-Base Voltage	VCBO	-100	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current — Continuous	IC	-300	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

THE THINK OF A TANK OF EMOTION	TIETUVAE OTVATAOTETOO					
Characteristic	Symbol	Max	Unit			
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W			
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W			

BC450,A

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

PNP SILICON

Refer to MPS8598 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteris	tic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS				80	IT BUTTON	AHD FR
Collector-Emitter Breakdown Voltage* (I _C = -1.0 mAdc, I _B = 0)	NaR)cso	V(BR)CEO	-100	kdow <u>n</u> .Volta, = 0)	6 mil <u>ter</u> Brei 9 m.Ade. 1g	Vdc
Collector-Base Breakdown Voltage ($I_C = -100 \mu A, I_E = 0$)	VISIDORO BE	V(BR)CBO	-100	ogsil <u>aV</u> nwo e (t)	Bresid 10 p.Ádo. lg	Vdc
Emitter-Base Breakdown Voltage (I _E = -10μ Adc, I _C = 0)		V _{(BR)EBO}	-5.0		aluis <u>al</u> B exe = plubbay 8	Vdc
Collector Cutoff Current (V _{CB} = -80 Vdc, I _E = 0)	033	ICBO		dn 	-100	nAdd
ON CHARACTERISTICS*						
(I _C = -2.0 mA , V _{CE} = -5.0 V) (I _C = -10 mA , V _{CE} = -5.0 V)	BC450 BC450A BC450 BC450A BC450A	h _{FE}	50 120 50 100 50 60	CE = 20 Volc VCE = 2.0 Volc E = 5.0 Vool cution ollage	460 220 — — —	Currel (IC =)I) (IC =)I (IC =)I
Collector-Emitter Saturation Voltage (I _C = -100 mAdc, I _B = -10 mAdc)		V _{CE(sat)}		-0.125	-0.25	Vdc
Base-Emitter Saturation Voltage ($I_C = -100 \text{ mAdc}$, $I_B = -10 \text{ mAdc}$)	VBE(so:)	V _{BE} (sat)		-0.85	ter S <u>et</u> verti 19 mAde, Ig	Vdc
Base-Emitter On Voltage (I _C = -2.0 mA, V _{CE} = -5.0 V) (I _C = -100 mA, V _{CE} = -5.0 V)*		VBE(on)	- 0.55 —	 -0.76	-0.7 -1.2	Vdc
DYNAMIC CHARACTERISTICS			SHM 001 =	= 2.0 Vdg, f	goV JohAm I	1 = 511
Current-Gain — Bandwidth Product (IC = -50 mAdc, VCE = -5.0 Vdc, f	= 100 MHz)	fT	100	200	profines 10 Vdc. lg	MHz

^{*}Pulse Test: Pulse Width \leq 300 μs , Duty Cycle 2.0%.

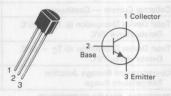
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	80	Vdc
Collector-Base Voltage	VCBO	80	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	IC	0.5	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	O° C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	Reic	83.3	°C/W

BC489,A,B

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



HIGH CURRENT TRANSISTORS

NPN SILICON

Refer to MPSA05 for graphs.

ELECTRICAL CHARACTERISTICS	$(T_A = 25^{\circ}C \text{ unless otherwise noted})$
Charac	enrictio

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS				21	ACCITUSTIC	AHD THO
Collector-Emitter Breakdown Voltage* (IC = 10 mAdc, IB = 0)	OSO(NE)V	V(BR)CEO	80	kdow n Voltage a = 0)	Banin al Breo 4.0 mAdo, i	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	У(высво	V(BR)CBO	80	opality made = 0)	bies o ses8	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	резілајУ	V(BR)EBO	5.0	epanuV mv	schaluerral eke 10 aArtou lo	Vdc
Collector Cutoff Current (V _{CB} = 60, Vdc — I _E = 0)	oual leno	ІСВО	<u> </u>	10 -	100	nAdc
ON CHARACTERISTICS*				98	ACCERBING	RAHS MO
BC	489 489A 489B	hFE 0334	60 100 160 15	160 260	400 250 400	mus c 00 - = <u>91</u> - = 55 - = 50
Collector-Emitter Saturation Voltage (I _C = 500 mAdc — I _B = 50 mAdc) (I _C = 1.0 Adc — I _B = 100 mAdc)		VCE(sat)	_ (s)	0.2 0.3	0.50	Vdc
Base-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc) (I _C = 1.0 Adc — I _B = 100 mAdc)*	(tas)36V	V _{BE} (sat)	_ (4)	0.85 0.90	1.20	Vdc
DYNAMIC CHARACTERISTICS	blume.				2.0 mA. Ven	- = oli
Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 2.0 Vdc, f = 100 MHz)		fT	-	200	100 mA, Wo	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	71	Cob	00f = 1.0	bulber 7 dibiy	dansâ l - nis 60 milyde, V	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)		C _{ib}	20 to	50	Pulse Width	pF

^{*}Pulse Test — Pulse Width = 300 µs — Duty Cycle 2%.

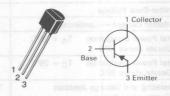
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-80	Vdc
Collector-Base Voltage	VCBO	-80	Vdc
Emitter-Base Voltage	VEBO	-4.0	Vdc
Collector Current — Continuous	IC	-0.5	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W

BC490,A

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



HIGH CURRENT TRANSISTORS

PNP SILICON

Refer to MPSA55 for graphs in MPSA05 data sheet.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS			5	ACTERS NO	LAND THE
Collector-Emitter Breakdown Voltage* (IC = -10 mAdc, I _B = 0)	V(BR)CEO	-80	dowd_voltage (0) =	Britis III dinibi O medo, Yigi	Vdc
Collector-Base Breakdown Voltage (I _C = -100 μAdc, I _E = 0)	V(BR)CBO	-80	wn Valtage 0)	Bases <u>Br</u> onted JuAdo, Ip =	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc, I_C = 0$)	V(BR)EBO	-4.0	ela <u>st</u> on w	ice B <u>ua</u> nkdos 10 hAdb. Igu	Vdc
Collector Cutoff Current (V _{CB} = -60 Vdc — I _E = 0)	ІСВО	-	- 1	-100	nAdc
ON CHARACTERISTICS*					
DC Current Gain	hFE	40 60 100 15	140	400 250	VGB =
Collector-Emitter Saturation Voltage (I _C = -500 mAdc, I _B = -50 mAdc) (I _C = -1.0 Adc, I _B = -100 mAdc)	VCE(sat)	=	-0.25 -0.50	- 0.50 —	Vdc
Base-Emitter Saturation Voltage ($I_C = -500 \text{ mAdc}$, $I_B = -50 \text{ mAdc}$) ($I_C = -1.0 \text{ Adc}$, $I_B = -100 \text{ mAdc}$)	V _{BE(sat)}	=	-0.90 -1.00	-1.20 -	Vdc
DYNAMIC CHARACTERISTICS				HAMD JAME	e-Timbe
Current-Gain — Bandwidth Product (I _C = -50 mAdc, V _{CE} = -2.0 Vdc, f = 100 MHz)	fT	(8) - 100 MHb)	150	an — <u>s</u> acov Jaskao, Vos	MHz
Output Capacitance ($V_{CB} = -10 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C _{ob}	_	9	Falled Market	pF
Input Capacitance	C _{ib}		110		pF

 $V_{EB} = -0.5 \text{ Vdc}$, $V_{C} = 0$, $V_{C} = 0$, $V_{C} = 0$, $V_{C} = 0$. While $V_{C} = 0$ and $V_{C} = 0$. The $V_{C} = 0$ and $V_{C} = 0$.

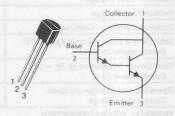
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCES	30	Vdc
Collector-Base Voltage	V _{CB}	40	Vdc
Emitter-Base Voltage	VEB	10	Vdc
Collector Current — Continuous	Ic	1.0	Adc
Total Power Dissipation T _A = 25°C Derate above 25°C	PD	625 12	mW mW/°C
Total Power Dissipation T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	R _θ JC	83.3	°C/W

BC517

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

NPN SILICON

Refer to 2N6426 for graphs.

ELECTRICAL CH	IARACTERISTICS	$(T_{\Delta} =$	25°C unless	otherwise r	noted.)
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Characte	eristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					В	ACTERISTIC	RARO SR
Collector-Emitter Breakdown Voltage (I _C = 2.0 mAdc, V _{BE} = 0)	08	Vienceo	V(BR)CES	30	rpshor—roba rpshor—roba	Senti a tteri 10 mAdo, Ig	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _E = 0)	08-	OSD(RS)V	V(BR)CBO	40	agai lu V nua e 0)	lala é ré pest 1.00 _M Ado, Ig	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 nAdc, I _C = 0)	-4.0	CABLISETY	V(BR)EBO	10	nyo m oV n = 0)	aa C or aketes 10 askata, ka	Vdc
Collector Cutoff Current (VCE = 30 V)		ogot	ICES		(0 + p)	500	nA
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0)			ICBO	-		100	nAdc
Emitter Cutoff Current VEB = 10 Vdc, IC = 0)	on- oa-		I _{EBO}	— isav (de) (de)	VCE = -20 VCE = -20	100	nAdc
ON CHARACTERISTICS (1)	100		Anex	98			
DC Current Gain (I _C = 20 mAdc, V _{CE} = 2.0 V)		VCE(Eat)	hFE	30,000	eganoV natis	ulad attima	in organical form
Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 0.1 mAdc)			VCE(sat)	- 18	paam vo r – a	1.0	Vdc
Base-Emitter On Voltage (I _C = 10 mAdc, V _{CE} = 5.0 Vdc)		(RE)38Y	V _{BE(on)}	de)	Am 00 = g	1.4	Vdc
SMALL-SIGNAL CHARACTERISTICS					physical	RESERVE	SIBLAMY
Current-Gain — Bandwidth Product (2 (IC = 10 mAdc, VCE = 5.0 Vdc, f =		2)	fT	T 801 + 1 a	200	vbnoti — nie	MHz

⁽¹⁾ Pulse Test Pulse Width ≤ 2.0%.

(2) f_T = |h_{fe}| • f_{test}

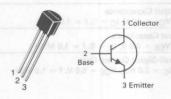
Rating	Symbol	BC 546	BC 547	BC 548	Unit
Collector-Emitter Voltage	VCEO	65	45	30	Vdc
Collector-Base Voltage	VCBO	80	50	30	Vdc
Emitter-Base Voltage	VEBO		6.0	Vdc	
Collector Current - Continuous	IC	100	100	mAdc	
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	dej/D	625 5.0	mW mW/°C	
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	ed-	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-58	-55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	R_{θ} JC	83.3	°C/W

BC546, A, B BC547, A, B, C BC548, A, B, C

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	PICALAE 2 - "SAT	Mars 1	MERRUD O	G DESTILATED D	10W - 1 37	Subia.
Collector-Emitter Breakdown Voltage (I _C = 1.0 mA, I _B = 0)	BC546 BC547 BC548	V(BR)CEO	65 45 30		Ŧ	V
Collector-Base Breakdown Voltage (I _C = 100 μ Adc)	BC546 BC547 BC548	V(BR)CBO	80 50 30			V
Emitter-Base Breakdown Voltage (I _E = 10 μ A, I _C = 0)	BC546 BC547 BC548	V(BR)EBO	6.0 6.0 6.0			V
Collector Cutoff Current (V _{CE} = 70 V, V _{BE} = 0) (V _{CE} = 50 V, V _{BE} = 0) (V _{CE} = 35 V, V _{BE} = 0) (V _{CE} = 30 V, T _A = 125°C)	BC546 BC547 BC548 BC546/547/548	ICES		0.2 0.2 0.2 0.2	15 15 15 4.0	nA μA
ON CHARACTERISTICS	103 0 - 450 ED - 110					
DC Current Gain (I _C = 10 μ A, V _{CE} = 5.0 V)	BC546A/547A/548A BC546B/547B/548B BC548C	h _{FE}	=	90 150 270	Ē	-
$(I_C = 2.0 \text{ mA}, V_{CE} = 5.0 \text{ V})$	BC546 BC547 BC548 BC546A/547A/548A BC546B/547B/548B BC547C/BC548C	75 8 - A A	110 110 110 110 200 420	180 290 520	450 800 800 220 450 800	EU213
$(I_C = 100 \text{ mA, V}_{CE} = 5.0 \text{ V})$	BC546A/547A/548A BC546B/547B/548B BC548C			120 180 300	=	
Collector-Emitter Saturation Voltage (I _C = 10 mA, I _B = 0.5 mA) (I _C = 100 mA, I _B = 5.0 mA) (I _C = 10 mA, I _B = See Note 1)	Supra	VCE(sat)		0.09 0.2 0.3	0.25 0.6 0.6	V
Base-Emitter Saturation Voltage (I _C = 10 mA, I _B = 0.5 mA)		VBE(sat)		0.7		V
Base-Emitter On Voltage (I _C = 2.0 mA, V_{CE} = 5.0 V) (I _C = 10 mA, V_{CE} = 5.0 V)	gu Tiù	VBE(on)	0.55	190 (1940 30)	0.7 0.77	V

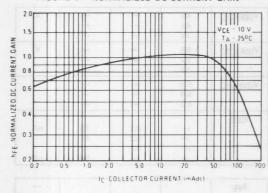
NOTE 1: IB is value for which $I_C = 11$ mA at $V_{CE} = 1.0$ V.

BC546, A, B BC547, A, B, C BC548, A, B, C

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
SMALL-SIGNAL CHARACTERISTICS	Hall 36 36 36 Indmyd gelfaß.					
Current-Gain Bandwidth Product ($I_C = 10$ mA, $V_{CE} = 5.0$ V, $f = 100$ MHz)	BC546 BC547 BC548	fτ 08	150 150 150	300 300 300	etluv <u>s</u> ettin epetl u v ees	MHz
Output Capacitance (V _{CB} = 10 V, I _C = 0, f = 1.0 MHz)	otiAm 0	C _{obo}	+	1.7	4.5	pF
Input Capacitance (VEB = 0.5 V, I _C = 0, f = 1.0 MHz)	25/Wm 0	C _{ibo}	4 30	10	Ove ZelfC	pF
Small-Signal Current Gain (IC = 2.0 mA, VCE = 5.0 V, f = 1.0 kHz)	BC546 BC547/548 BC546A/547A/548A BC546B/547B/548B BC547C/548C	h _{fe}	125 125 125 240 450	220 330 600	500 900 260 500 900	Da—le n pureting Tampera TERNIAL
Noise Figure (I _C = 0.2 mA, V _{CE} = 5.0 V, R _S = 2 kohms, f = 1.0 kHz, Δf = 200 Hz)	BC546 BC547 BC548	NF 88	lent Re	2.0 2.0 2.0	10 10 10	dB

FIGURE 1 - NORMALIZED DC CURRENT GAIN



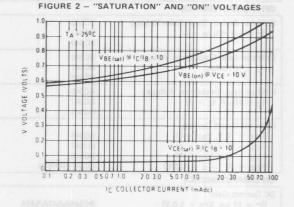


FIGURE 3 - COLLECTOR SATURATION REGION

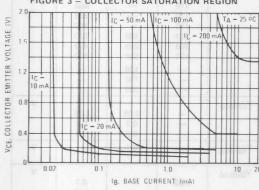
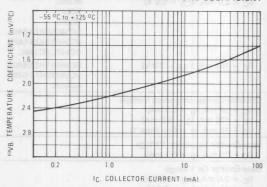


FIGURE 4 - BASE EMITTER TEMPERATURE COEFFICIENT



BC547/BC548

FIGURE 5 - CAPACITANCES

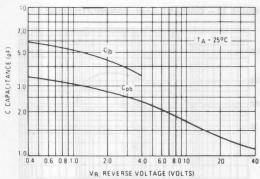


FIGURE 6 - CURRENT GAIN-BANDWIDTH PRODUCT

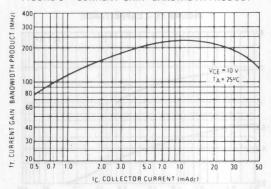


FIGURE 7 - DC CURRENT GAIN

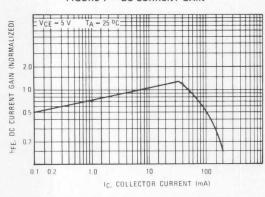


FIGURE 8 - "ON" VOLTAGE

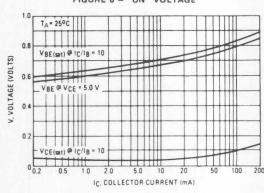


FIGURE 9 - COLLECTOR SATURATION REGION

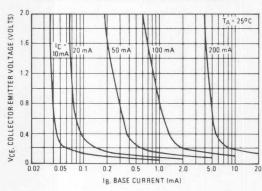
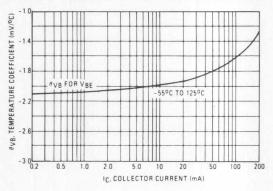
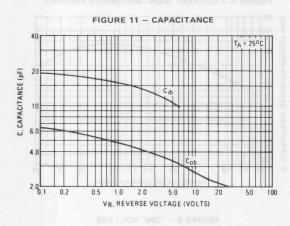
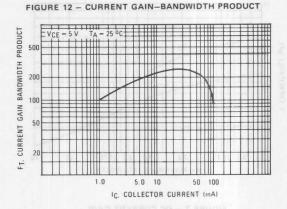
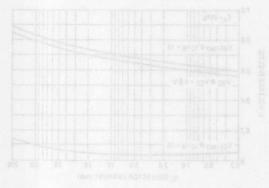


FIGURE 10 - BASE EMITTER TEMPERATURE COEFFICIENT

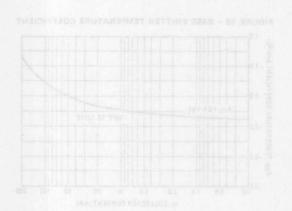


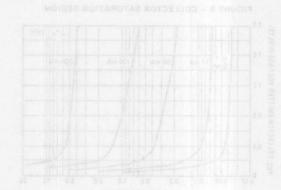












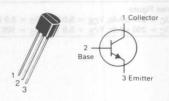
Rating w/	Symbol	BC 549	BC 550	Unit
Collector-Emitter Voltage	VCEO	30	45	Vdc
Collector-Base Voltage	VCBO	30	50	Vdc
Emitter-Base Voltage	VEBO	5.0		Vdc
Collector Current - Continuous	IC	100		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-55 to +150		°C

THERMAL CHARACTERISTICS

THE HIMAE OHAHAOTEHIOTIOO			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	R ₀ .IC	83.3	°C/W

BC549B,C BC550B,C

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



LOW NOISE TRANSISTORS

NPN SILICON

ELECTRICAL CHARACTERISTICS (TA = 25 °C unless otherwise noted)

Characteristic	Symbol	Min.	Тур.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0) BC549B,C BC550B,C	V(BR)CEO	30 45			Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _E = 0) BC549B,C BC550B,C	V(BR)CBO	30 50			Vdc
Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0)	V(BR)EBO	5			Vdc
Collector Cutoff Current (VCB = 30 Vdc, IE = 0) (VCB = 30 Vdc, IE = 0, TA = + 125 °C)	СВО			15 5	nAdo μAdo
Emitter Cutoff Current (VEB = 4 Vdc, I _C = 0)	IEBO			15	nAdd
ON CHARACTERISTICS					
DC Current Gain $(I_C = 10 \mu Adc, V_{CE} = 5 Vdc)$ BC549B/550B BC549C/550C BC549B/550B BC549C/550C	hFE WAO TK!	100 100 200 420	150 270 290 500	450 800	DIA
Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 0.5 mAdc) (IC = 10 mAdc, IB = see note 1) (IC = 100 mAdc, IB = 5 mAdc, see note 2)	VCE(sat)		0.075 0.3 0.25	0.25 0.6 0.6	Vdc
Base-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 5 mAdc)	VBE(sat)		1.1		Vdc
Base-Emitter On Voltage (IC = 10 μAdc, VCE = 5 Vdc) (IC = 100 μAdc, VCE = 5 Vdc) (IC = 2 mAdc, VCE = 5 Vdc)	VBE(on)	0.55	0.52 0.55 0.62	0.7	Vdc
SMALL SIGNAL CHARACTERISTICS	. / 44-14	11			1
Current-Gain-Bandwidth Product (IC = 10 mAdc, VCE = 5 Vdc, f = 100 MHz)	fT		250		MHz
Collector-Base Capacitance	C _{cbo}	05 01	3.0 5.0	0.1	pF

 $(V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz})$ Note 1: IB is value for which IC = 11 mA at VCE = 1 V

Note 2: Pulse test = 300 μs - Duty cycle = 2%

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
Small-Signal Current Gain	Oac	h _{fe}				_
$(I_C = 2.0 \text{ mAdc}, V_{CE} = 5.0 \text{ V}, f = 1.0 \text{ kHz})$	BC549B/BC550B	68 05	240	330	500	totoell
	BC549C/BC550C	08 ne	450	600	900	-tolgell
Noise Figure		3 00	av I		se Voltene	dB
$(I_C = 200 \mu\text{Adc}, V_{CE} = 5.0 \text{Vdc}, R_S = 2.0 \text{k}\Omega, f = 1.0 \text{kHz})$		NF ₁	+	0.6	2.5	
$(I_C = 200 \mu\text{Adc}, V_{CE} = 5.0 \text{Vdc}, R_S = 100 \text{k}\Omega, f = 1.0 \text{kHz})$		NF ₂	-	Spanishing	10	107301

FIGURE 1 - TRANSISTOR NOISE MODEL

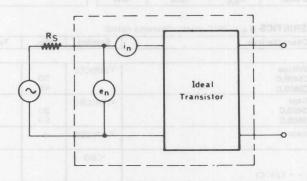


FIGURE 2 — NORMALIZED DC CURRENT GAIN

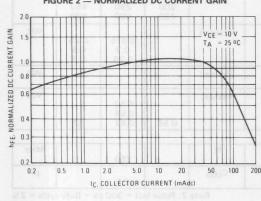
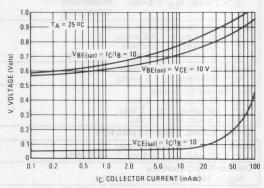
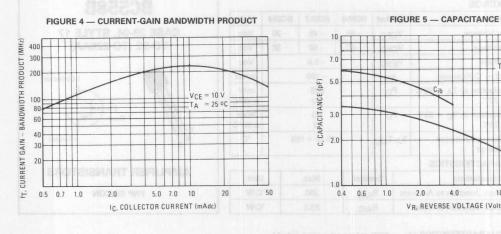
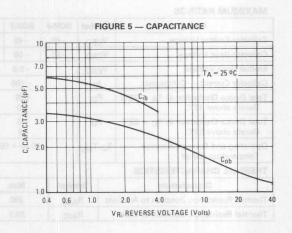
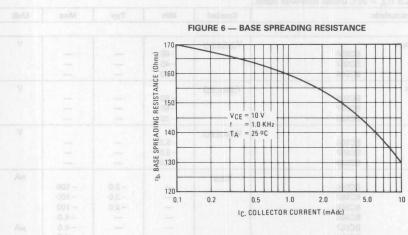


FIGURE 3 — "SATURATION" AND "ON" VOLTAGES









Rating MAGAO - 8 3	Symbol	BC556	BC557	BC558	Unit
Collector-Emitter Voltage	VCEO	-65	-45	-30	Vdc
Collector-Base Voltage	VCBO	-80	-50	-30	Vdc
Emitter-Base Voltage	VEBO		-5.0		Vdc
Collector Current — Continuous	Ic	-100			mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0			mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watt mW/°C	
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	R ₀ .IC	83.3	°C/W

BC556,B BC557,A,B,C BC558B

CASE 29-04, STYLE 17 TO-92 (TO-226AA)





AMPLIFIER TRANSISTORS

PNP SILICON

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	SPREADING RESISTANCE	BASE 8 BASE	4			
Collector-Emitter Breakdown Voltage (I _C = -2.0 mAdc, I _B = 0)	BC556 BC557 BC558	V(BR)CEO	-65 -45 -30		Ξ	٧
Collector-Base Breakdown Voltage (I _C = -100 μAdc)	BC556 BC557 BC558	V(BR)CBO	-80 -50 -30	Ξ	=	٧
Emitter-Base Breakdown Voltage ($I_E = -100 \mu Adc$, $I_C = 0$)	BC556 BC557 BC558	V(BR)EBO	-5.0 -5.0 -5.0	=	=	٧
Collector-Emitter Leakage Current (V _{CES} = -40 V) (V _{CES} = -20 V) (V _{CES} = -20 V, T _A = 125°C)	BC556 BC557 BC558 BC556 BC557 BC558	ICES		-2.0 -2.0 -2.0 - -	-100 -100 -100 -4.0 -4.0 -4.0	nA μA
ON CHARACTERISTICS					MALLEY	
DC Current Gain (I _C = $-10~\mu$ Adc, V _{CE} = $-5.0~\text{V}$) (I _C = $-2.0~\text{mAdc}$, V _{CE} = $-5.0~\text{V}$) (I _C = $-100~\text{mAdc}$, V _{CE} = $-5.0~\text{V}$)	BC557A BC556B/557B/558B BC557C BC556 BC557 BC558 BC557A BC556B/557B/558B BC557C BC557A BC556B/557B/558B BC557C	hFE	120 120 120 120 120 180 420	90 150 270 — — 170 290 500 120 180 300	500 800 800 220 460 800	
Collector-Emitter Saturation Voltage $(I_C = -10 \text{ mAdc}, I_B = -0.5 \text{ mAdc})$ $(I_C = -10 \text{ mAdc}, I_B = \text{see Note 1})$ $(I_C = -100 \text{ mAdc}, I_B = -5.0 \text{ mAdc})$		VCE(sat)	Ξ	-0.075 -0.3 -0.25	-0.3 -0.6 -0.65	٧

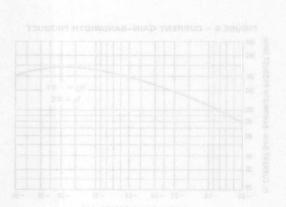
NOTE 1: $I_C = -10$ mAdc on the constant base current characteristics, which yields the point $I_C = -11$ mAdc, $V_{CE} = -1.0$ V.

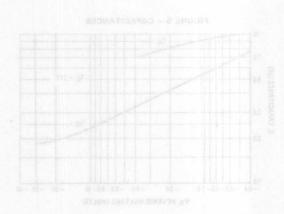
BC556,B BC557,A,B,C BC558B

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

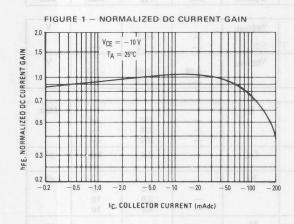
Characteristic		Symbol	Min	Тур	Max	Unit
ON CHARACTERISTICS (continued)				or extended to	COLORS E T	CHI POLIS
Base-Emitter Saturation Voltage ($I_C = -10$ mAdc, $I_B = -0.5$ mAdc) ($I_C = -100$ mAdc, $I_B = -5.0$ mAdc)	11 00-	V _{BE} (sat)	1	- 0.7 - 1.0	= 30% 11	V
Base-Emitter On Voltage $ \begin{aligned} &(I_C = -2.0 \text{ mAdc, } V_{CE} = -5.0 \text{ Vdc)} \\ &(I_C = -10 \text{ mAdc, } V_{CE} = -5.0 \text{ Vdc)} \end{aligned} $		V _{BE(on)}	- 0.55 	-0.62 -0.7	-0.7 -0.82	V
SMALL-SIGNAL CHARACTERISTICS	77744-8					
Current-Gain Bandwidth Product (I _C = -10 mA, V _{CE} = -5.0 V, f = 100 MHz)	BC556 BC557 BC558	fT	Ē	280 320 360	=	MHz
Output Capacitance ($V_{CB} = -10 \text{ V}, I_{C} = 0, f = 1.0 \text{ MHz}$)		C _{ob}		3.0	6.0	pF
Noise Figure (I _C = -0.2 mAdc, V _{CE} = -5.0 V, R _S = 2 k ohms, f = 1.0 kHz, Δ f = 200 Hz)	BC556 BC557 BC558	NF	- <u>8</u> - 6	2.0 2.0 2.0	10 10 10	dB
Small-Signal Current Gain (I _C = -2.0 mAdc, V _{CE} = -5.0 V, f = 1.0 kHz)	BC556 BC557/558 BC557A BC556B/557B/558B BC557C	h _{fe}	125 125 125 240 450	220 330 600	500 900 260 500 900	Rupi

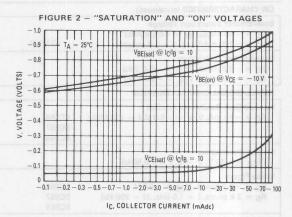


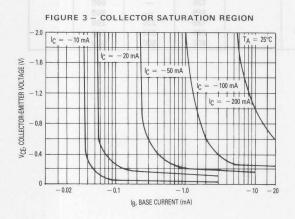


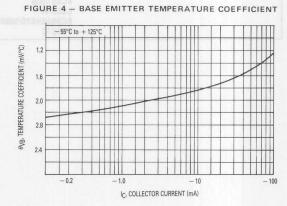


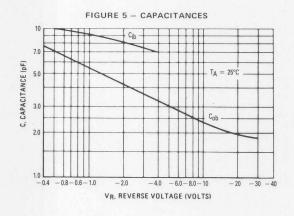
BC557/BC558

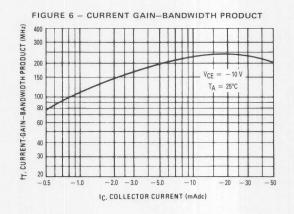


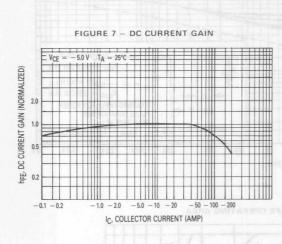


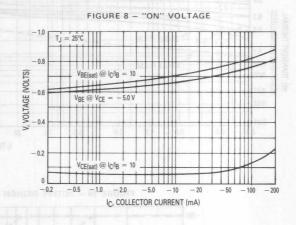


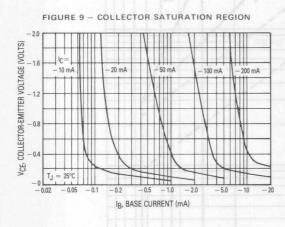


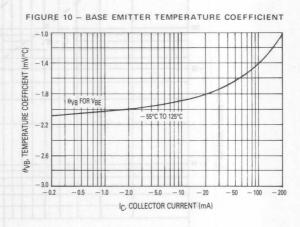


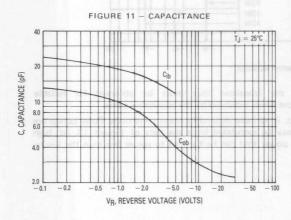












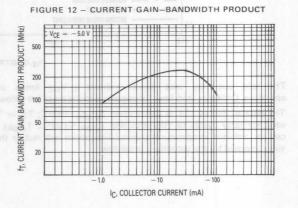


FIGURE 13 - THERMAL RESPONSE

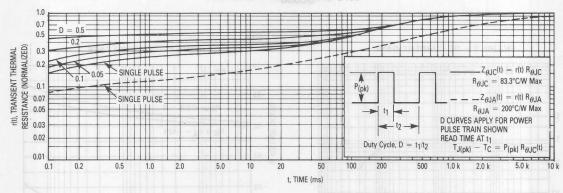
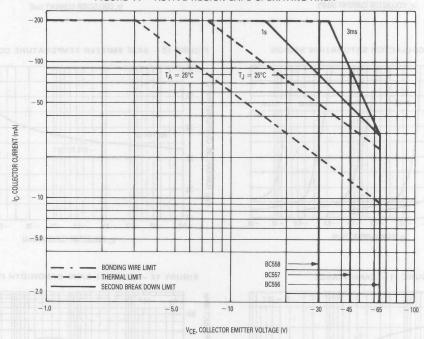


FIGURE 14 - ACTIVE REGION SAFE OPERATING AREA



The safe operating area curves indicate IC-VCE limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 14 is based upon $T_{J(pk)}=150^{\circ}C$; T_{C} or T_{A} is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \le 150^{\circ}C$. $T_{J(pk)}$ may be calculated from the data of Figure 13. At high case or ambient temperatures thermal limitations will reduce the power that can be handled to values less than the limitations imposed by the secondary breakdown.

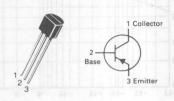
		DOFFE	DOFOO	
Rating	Symbol	BC559	BC560	Unit
Collector-Emitter Voltage	VCEO	-30 -45		Vdc
Collector-Base Voltage	VCBO	-30 -50		Vdc
Emitter-Base Voltage	VEBO	-5.0		Vdc
Collector Current — Continuous	Ic	-100		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

DUUUU, D, U BC560B, C

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



LOW NOISE TRANSISTORS

PNP SILICON

nAdc

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I _C = -10 mAdc, I _B = 0)	BC559 BC560	V(BR)CEO	-30 -45			Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc, I_E = 0$) BC559 BC560		V(BR)CBO	-30 -50	Ξ	=	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc, I_C = 0$)		V(BR)EBO	-5			Vdc
Collector Cutoff Current ($V_{CB} = -30 \text{ Vdc}$, $I_{E} = 0$) ($V_{CB} = -30 \text{ Vdc}$, $I_{E} = 0$, $T_{A} = +125^{\circ}\text{C}$)		ICBO	=		-15 -5	nAdc μAdc

IEBO

	ON	CHARA	CTERIST	ICS
--	----	-------	---------	-----

Emitter Cutoff Current $(V_{EB} = -4.0 \text{ Vdc}, I_{C} = 0)$

DC Current Gain		hee				_
$(I_C = -10 \mu\text{Adc}, V_{CE} = -5.0 \text{Vdc})$	BC559B/560B		100	150	_	
	BC559C/560C		100	270	_	
$(I_C = -2.0 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc})$	BC559B/560B	S TOMB - 1	180	290	460	
	BC559C/560C		380	500	800	
	BC559		120	_	800	
Collector-Emitter Saturation Voltage		VCE(sat)		I TO THE	HEAT I L.	Vdc
$(I_C = -10 \text{ mAdc}, I_B = -0.5 \text{ mAdc})$		02(001)		-0.075	-0.25	
$(I_C = -10 \text{ mAdc}, I_B = \text{see note 1})$			_	-0.3	-0.6	
$(I_C = -100 \text{ mAdc}, I_B = -5.0 \text{ mAdc}, \text{see note})$	2)		_	-0.25	-	
Base-Emitter Saturation Voltage		V _{BE(sat)}	1 1	-1.1	<u> </u>	Vdc
$(I_C = -100 \text{ mAdc}, I_B = -5.0 \text{ mAdc})$		VR 3V				
Base-Emitter On Voltage		VBE(on)	1 0	- 6	STATE OF	Vdc
$(I_C = -10 \mu\text{Adc}, V_{CE} = -5.0 \text{Vdc})$				-0.52	_	
$(I_C = -100 \mu\text{Adc}, V_{CE} = -5.0 \text{Vdc})$			_	-0.55	_	
$(I_C = -2.0 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc})$			-0.55	-0.62	-0.7	

SMALL-SIGNAL CHARACTERISTICS

Current-Gain — Bandwidth Product (I _C = -10 mAdc, V _{CE} = -5.0 Vdc, f = 100 MHz)	fT	50- 10	250	_	MHz
Collector-Base Capacitance ($V_{CB} = -10$ Vdc, $I_E = 0$, $f = 1.0$ MHz)	C _{cbo}		2.5	-	pF
Small-Signal Current Gain (I _C = -2.0 mAdc, V _{CE} = -5.0 V, f = 1.0 kHz) BC559B/BC560B BC559C/BC560C	h _{fe}	240 450	330 600	500 900	-
Noise Figure (I _C = $-200~\mu$ Adc, V _{CE} = $-5.0~\text{Vdc}$, R _S = $2.0~\text{k}\Omega$, f = $1.0~\text{kHz}$) (I _C = $-200~\mu$ A, V _{CE} = $-5.0~\text{V}$, R _S = $100~\text{k}\Omega$, f = $1.0~\text{kHz}$, Δ f = $200~\text{Hz}$)	NF ₁ NF ₂	=	0.5	2.0 10	dB

Note 1: I_B is value for which I_C = -11 mA at V_{CE} = -1.0 V

Note 2: Pulse test = 300 μ s — Duty cycle = 2%.

BC559, B, C BC560B, C

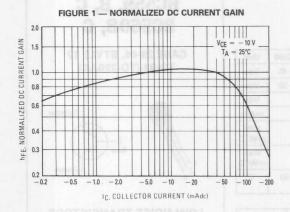


FIGURE 2 — "SATURATION" AND "ON" VOLTAGES

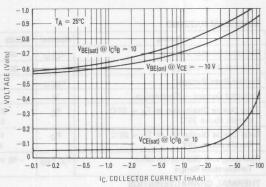


FIGURE 3 — CURRENT-GAIN BANDWIDTH PRODUCT

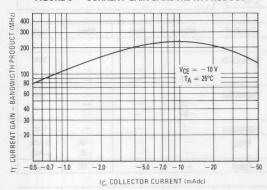


FIGURE 4 — CAPACITANCE

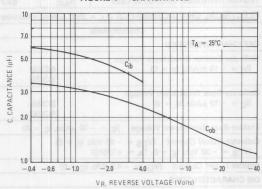
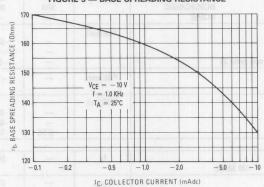


FIGURE 5 — BASE SPREADING RESISTANCE



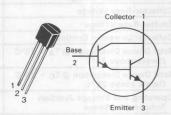
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	55	Vdc
Collector-Base Voltage	VCBO	80	Vdc
Emitter-Base Voltage	VEBO	12	Vdc
Collector Current — Continuous	Ic	1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	on ∃ oc ⊟

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

BC618

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

NPN SILICON

Refer to 2N6426 for graphs.

Characte	ristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						a semi-repres	Annual Sec
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, V _{BE} = 0)	48	(130HB)*	V _(BR) CEO	55	- 10	gr, oc Am 0	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	08	herwariV	V _(BR) CBO	80	epetioV own	land Drogled	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)	4B 00		V _{(BR)EBO}	12	_ (0 +	gd.sd <u>.</u> Au, 00	Vdc
Collector Cutoff Current (VCE = 60 Vdc, VBE = 0)	0.8	CHRIST	ICES	18	op <u>es</u> oV m	50	nAdc
Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0)		080/	ICBO	_	10	50	nAdc
Emitter Cutoff Current (VEB = 10 Vdc, I _C = 0)			IEBO	- 101	0, T _A = 12	50	nAdc
ON CHARACTERISTICS					- 40	OF HEIRING COA	JACON BUT
Collector-Emitter Saturation Voltage (I _C = 200 mA, I _B = 0.2 mA)	86	394	V _{CE(sat)}	-	= 2.0 Vdat	1.1	Vdc
Base-Emitter Saturation Voltage (I _C = 200 mA, I _B = 0.2 mA)	06 04		V _{BE(sat)})8 —)8	-	1.6	Vdc
Current Gain (I _C = 100μA, V _{CE} = 5.0 V) (I _C = 10 mA, V _{CE} = 5.0 V)	- 25	Use/30 ^V	hFE	2000 4000	+ 2.0 V) effor -v oltegr = 60 Add	M ma, Vice Settler Settler M m = 16	t = <u>nl</u>) notsetto0 0 = nt)
$(I_C = 200 \text{ mA}, V_{CE} = 5.0 \text{ V})$ $(I_C = 1.0 \text{ A}, V_{CE} = 5.0 \text{ V})$				10000 4000	(a) a) B (c) a)	50000	im3-ebi8
DYNAMIC CHARACTERISTICS						Simple Report	CORNEL MARKET
Current-Gain — Bandwidth Product (I _C = 500 mA, V _{CE} = 5.0 V, P = 10	0 MHz)	ęl l	fŢ	150	th Product	bhybnatt nin	MHz
Output Capacitance (V _{CB} = 10 V, I _E = 0, f = 1.0 MHz)		Cob	C _{ob}		4.5	7.0	pF
Input Capacitance (VEB = 5.0 V, IE = 0, f = 1.0 MHz)		di ^O	C _{ib}	-	5.0	9.0	pF

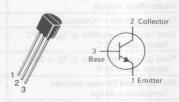
Rating	Symbol	BC 635	BC 637	BC 639	Unit
Collector-Emitter Voltage	VCEO	45	60	80	Vdc
Collector-Base Voltage	VCBO	45	60	80	Vdc
Emitter-Base Voltage	VEBO	Vdc	5.0		Vdc
Collector Current - Continuous	IC	oba	0.5		Adc
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	Win ChiWit	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	TIEVV	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-55 to +150		°C	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	RAIC	83.3	°C/W

BC635 BC637 BC639

CASE 29-04, STYLE 14 TO-92 (TO-226AA)



HIGH CURRENT TRANSISTORS

NPN SILICON

Characte	eristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	371101	tomings		900	Christian Control		
Collector-Emitter Breakdown Voltage* (I _C = 10 mAdc, I _B = 0)	BC	C635 (1997) C637	V(BR)CEO	45 60	Kdowo Voltare	senti <u>sa</u> tsimi. 16V v <u>ob</u> ární	Vdc
aby — Van	BC	639		80	age/l ol / rwk	halasi di saat	notaelle:
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	BC	C635 C637 C639	V(BR)CBO	45 60 80	0 m m Vollings q) —	al poAs, of	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	-	000	V(BR)EBO	5.0	-(0 =	ggV Li V 08	Vdc
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0, (V _{CB} = 30 Vdc, I _E = 0, T _A = 125°C	:)	oest oest	ІСВО		10 -	100 10	nAdc μAdc
ON CHARACTERISTICS*						nerenia i sa	DANS IN
DC Current Gain (I _C = 5.0 mAdc, V_{CE} = 2.0 Vdc) (I _C = 150 mAdc, V_{CE} = 2.0 Vdc)	ВС	C635 C637 C639	hFE	25 40 40 40	ation Voltage 0.2 mA) in Voltage 0.2 mA)	250 160 160	hotosilot S = (nf) Iun3-seai Lun3-seai
$(I_C = 500 \text{ mA}, V_{CE} = 2.0 \text{ V})$		and and		25	_	-	menu
Collector-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc)	2000		VCE(sat)	-	8.0 VI. 5.0 VI	0.5	Vdc
Base-Emitter On Voltage (I _C = 500 mAdc, V _{CE} = 2.0 Vdc)	00001		VBE(on)	-	[V 0/6	1.0	Vdc
DYNAMIC CHARACTERISTICS					SURFERN	A TOWNSON	ONVERMENT
Current-Gain Bandwidth Product (I _C = 50 mAdc, V _{CE} = 2.0 Vdc, f =	100 MHz)		fT	tsHM go	200	30 ^V Am 0	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MH:	z)	do ²	C _{ob}	-	7.0) = ALV-OL	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MH	z)	die	C _{ib}	-	50	= 3EV 0.8	pF

^{*}Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle 2.0%.

FIG. 1 — ACTIVE REGION SAFE OPERATING AREA

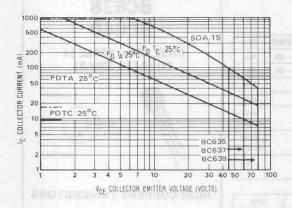


FIG. 2 — DC CURRENT GAIN

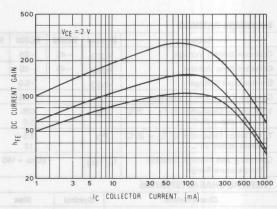
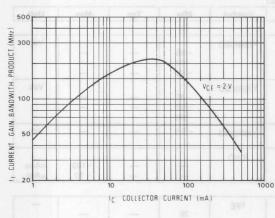
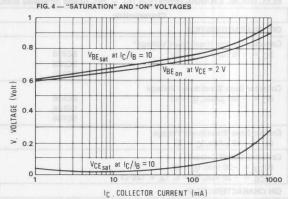
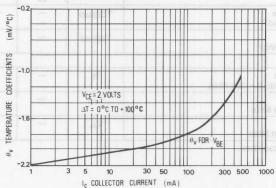


FIG. 3 — CURRENT GAIN BANDWIDTH PRODUCT





 ${\bf FIG.~5-TEMPERATURE~COEFFICIENTS}$



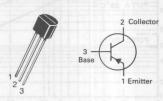
Rating	Symbol	BC636	BC638	BC640	Unit			
Collector-Emitter Voltage	VCEO	- 45	-60	-80	Vdc			
Collector-Base Voltage	VCBO	-45	-60	-80	Vdc			
Emitter-Base Voltage	VEBO		-5.0		Vdc			
Collector Current — Continuous	lc	-0.5			-0.5			Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0			mW mW/°C			
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12			Watt mW/°C			
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150			°C			

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	RAIC	83.3	°C/W

BC636 BC638 BC640

CASE 29-04, STYLE 14 TO-92 (TO-226AA)



HIGH CURRENT TRANSISTORS

PNP SILICON

Characteristic			Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS			1411-1-1	1-111-			
Collector-Emitter Breakdown Voltage* (IC = -10 mAdc, IB = 0)	BC636 BC638 BC640	6.0	V(BR)CEO	- 45 - 60 - 80	Ē	Ē	Vdc
Collector-Base Breakdown Voltage (I _C = -100 μAdc, I _E = 0)	BC636 BC638 BC640	The sea	V(BR)CBO	- 45 - 60 - 80	=		Vdc
Emitter-Base Breakdown Voltage (I _E = -10 μAdc, I _C = 0)		50 ×	V(BR)EBO	-5.0			Vdc
Collector Cutoff Current ($V_{CB} = -30 \text{ Vdc}$, $I_{E} = 0$) ($V_{CB} = -30 \text{ Vdc}$, $I_{E} = 0$, $T_{A} = 125^{\circ}\text{C}$)	NEE.	o o	ІСВО		=	-100 -10	nAdc μAdc
ON CHARACTERISTICS*			Clear.	907	0		
DC Current Gain $ \begin{aligned} &\text{(I}_C = -5.0 \text{ mAdc, V}_{CE} = -2.0 \text{ Vdc)} \\ &\text{(I}_C = -150 \text{ mAdc, V}_{CE} = -2.0 \text{ Vdc)} \end{aligned} $ $ \end{aligned} $ $ \end{aligned} \end{aligned} $ $ \end{aligned} \end{aligned} $ $ \end{aligned} \end{aligned} \end{aligned} $ $ \end{aligned} \end{aligned} \end{aligned} \end{aligned}$	BC636 BC638 BC640	STREETERS	hFE	25 40 40 40 25	= = =	250 160 160	_
Collector-Emitter Saturation Voltage (I _C = -500 mAdc, I _B = -50 mAdc)			V _{CE(sat)}		-0.25 -0.5	-0.5 -	Vdc
Base-Emitter On Voltage (I _C = -500 mAdc, V _{CE} = -2.0 Vdc)			V _{BE(on)}	-	(m) -	-1.0	Vdc
DYNAMIC CHARACTERISTICS					2		
Current-Gain — Bandwidth Product $(I_C = -50 \text{ mAdc}, V_{CE} = -2.0 \text{ Vdc}, f = 10)$	0 MHz)		fT		150	-	MHz
Output Capacitance (V _{CB} = -10 Vdc, I _E = 0, f = 1.0 MHz)		D*Br	C _{ob}	-	9.0	-	pF
Input Capacitance (V _{EB} = -0.5 Vdc, I _C = 0, f = 1.0 MHz)			C _{ib}	1-1	110	-	pF

^{*}Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle 2.0%.

BC636 BC638 BC640

FIG. 1 — ACTIVE REGION SAFE OPERATING AREA

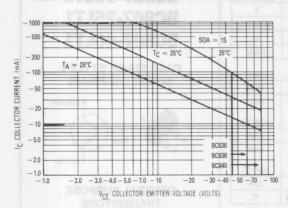


FIG. 2 — DC CURRENT GAIN

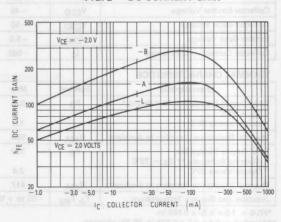


FIG. 3 — CURRENT GAIN BANDWIDTH PRODUCT

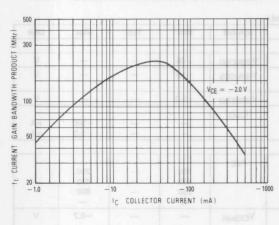


FIG. 4 — "SATURATION" AND "ON" VOLTAGES

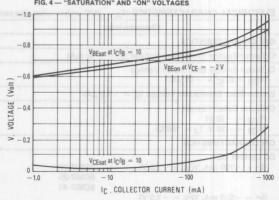
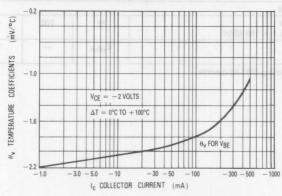


FIG. 5 — TEMPERATURE COEFFICIENTS



Rating Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-45	V
Collector-Base Voltage	V _{CBO}	-50	V
Emitter-Base Voltage	V _{EBO}	-5.0	V
Collector Current — Continuous	Ic	-500	mAdo

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	TJ, Tstq	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BC807-16LT1 = 5A; BC807-25LT1 = 5B; BC807-40LT1 = 5C

BC807-16LT1 BC807-25LT1 BC807-40LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTORS

PNP SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					- 0
Collector-Emitter Breakdown Voltage (I _C = −10 mA)	V(BR)CEO	-45			V
Collector-Emitter Breakdown Voltage (VEB = 0, I _C = -10 μA)	V _(BR) CES	-50			V
Emitter-Base Breakdown Voltage ($I_E = -1.0 \mu A$)	V(BR)EBO	-5.0		HT-T	V
Collector Cutoff Current ($V_{CB} = -20 \text{ V}$) ($V_{CB} = -20 \text{ V}$, $T_{J} = 150^{\circ}\text{C}$)	Ісво	=	=	- 100 - 5.0	nA μA
ON CHARACTERISTICS					
DC Current Gain $(I_C = -100 \text{ mA, V}_{CE} = -1.0 \text{ V})$ BC807-16 BC807-25 BC807-40 $(I_C = -500 \text{ mA, V}_{CE} = -1.0 \text{ V})$	hFE	100 160 250 40	01 01 01 01 01 01 01 01 01	250 400 600	0.7
Collector-Emitter Saturation Voltage (I _C = -500 mA, I _B = -50 mA)	V _{CE(sat)}		_	-0.7	V
Base-Emitter On Voltage (I _C = -500 mA, I _B = -1.0 V)	V _{BE(on)}	- tan	-	-1.2	V
SMALL-SIGNAL CHARACTERISTICS		- 12		Tall Tall	
Current-Gain — Bandwidth Product (I _C = -10 mA, V _{CE} = -5.0 Vdc, f = 100 MHz)	fT	200	-	-	MHz
Output Capacitance (V _{CB} = -10 V, f = 1.0 MHz)	C _{obo}		10	-	pF

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

MAXIMOM HATINGO				_
Rating	Symbol	Value	Unit	
Collector-Emitter Voltage	VCEO	45	V	
Collector-Base Voltage	V _{CBO}	50	V	
Emitter-Base Voltage	VEBO	5.0	V	
Collector Current — Continuous	Ic	500	mAdc	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_{A} = 25^{\circ}C$	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BC817-16LT1 = 6A; BC817-25LT1 = 6B; BC817-40LT1 = 6C

BC817-16LT1 BC817-25LT1 BC817-40LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTORS

NPN SILICON

Chara	acteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	150		J.B.ADAGGER .	AGANESIO	Tree Tree	1/401	0 = 0
Collector-Emitter Breakdown Volta	ge (I _C =	-10 mA)	V(BR)CEO	45	cultion purch	dencia varrier	V
Collector-Emitter Breakdown Volta (V _{EB} = 0, I _C = -10 μA)	ge 0		V(BR)CES	50	- (i = 1 10 √. Aug	V_
Emitter-Base Breakdown Voltage (I	E = -1.0	μΑ)	V(BR)EBO	5.0	on Vo ll age	geq D akdor	V
Collector Cutoff Current (V _{CB} = 20 V) (V _{CB} = 20 V, T _A = 150°C)	90 30 0.0	oder(88)/V	ІСВО	8C847A,B,C 8C848A,B,C	e—iioV e	100 5.0	nΑ μΑ
ON CHARACTERISTICS	6.0			RUSHIFA, B, I		I. (Au) = 30
DC Current Gain (I _C = 100 mA, V _{CE} = 1.0 V) (I _C = 500 mA, V _{CE} = 1.0 V)		BC817-16 BC817-25 BC817-40	hFE	100 160 250 40	(Vcs = 30V)	250 400 600	ollestor C
Collector-Emitter Saturation Voltage (IC = 500 mA, IB = 50 mA)	je	and .	VCE(sat)	.00867C	- (V 0.	0.7	V
Base-Emitter On Voltage (I _C = 500 mA, V _{CE} = 1.0 V)	200		V _{BE(on)}	BC846A	(V 0.8	1.2	V V
SMALL-SIGNAL CHARACTERISTIC	S		BC947E, BCB18E,	.88483.2			
Current-Gain — Bandwidth Production (IC = 10 mA, VCE = 5.0 Vdc, f		z)	fr 8808	200	-	-	MHz
Output Capacitance (VCB = 10 V, f = 1.0 MHz)	0.00	Vegrant	C _{obo}	Am 01 = 50	10	mitter Satura	pF

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	BC846	BC847 BC850	BC848 BC849	Unit
Collector-Emitter Voltage	VCEO	65	45	30	V
Collector-Base Voltage	VCBO	80	50	30	V
Emitter-Base Voltage	VEBO	6.0	6.0	5.0	V
Collector Current — Continuous	Ic	100	100	100	mAdd

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T _A = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stq}	-55 to +150	°C

*FR-5 = $1.0 \times 0.75 \times 0.062$ in **Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina. **DEVICE MARKING**

BC846ALT1 = 1A; BC846BLT1 = 1B; BC847ALT1 = 1E; BC847BLT1 = 1F; BC847CLT1 = 1G; BC848ALT1 = 1J; BC848BLT1 = 1K; BC848CLT1 = 1L

BC846ALT1*, BLT1* BC847ALT1*, BLT1*, CLT1* BC848ALT1*, BLT1*, CLT1* BC849ALT1, BLT1, CLT1 BC850ALT1, BLT1, CLT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)



2 Emitter

GENERAL PURPOSE TRANSISTORS

NPN SILICON

*These are Motorola designated preferred devices.

Refer to BC546 for graphs.

Chara	cteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	(belon salwa	MC unless othe	- ATT 80	orenemen.	ALCHARA	OBETOS
Collector-Emitter Breakdown Voltage I _C = 10 mA)	BC846A,B BC847A,B,C, BC850A,B,C BC848A,B,C, BC849A,B,C	V(BR)CEO	65 45 30	- Chai	— элга <u>н</u> ита	V
Collector-Emitter Breakdown Voltage (I _C = 10 μ A, V _{EB} = 0)	BC846A,B BC847A,B,C, BC850A,B,C BC848A,B,C, BC849A,B,C	V(BR)CES	80 50 30	MoV <u>awoo</u> MoV—vob —(An	nest <u>i j</u> etilm nesti — inim lit — — i	V
Collector-Base Breakdown Voltage (I _C = 10 μA)	BC846A,B BC847A,B,C, BC850A,B,C BC848A,B,C, BC849A,B,C	V(BR)CBO	80 50 30	ans no V m	a Br ed ictor stell <u>C</u> urren	D Noticel
Emitter-Base Breakdown Voltage (I _E = 1.0 μ A)	BC846A,B BC847A,B,C BC848A,B,C, BC849A,B,C, BC850A,B,C	V(BR)/ebo	6.0 6.0 5.0	# 0a1	= A= V o ornamento	V
Collector Cutoff Current (V _{CB} = 30V) (V _{CB} = 30 V)	T _A = 150°C)	ІСВО	_	(<u>V</u> 0.t >	15 5.0	nA μA
ON CHARACTERISTICS	250	BC817-40				
DC Current Gain (I _C = 10 μ A, V _{CE} = 5.0 V)	BC846A, BC847A, BC848A BC846B, BC847B, BC848B BC847C, BC848C	hFE	= 01	90 150 270	undershin = p-Am	0 = 50 ector-5 0 = 50
(I _C = 2.0 mA, V _{CE} = 5.0 V)	BC846A, BC847A, BC848A, BC849A, BC850A BC846B, BC847B, BC848B, BC849B, BC850B BC847C, BC848C, BC849C, BC850C		110 200 420	180 290 520	220 450 800	0 = 10 0 = 10 0 = 10 0 = 10
Collector-Emitter Saturation Voltage (I _C = 10 mA, I _B = 0.5 mA) I _C = 100 mA, I _B = 5.0 mA)	VCE(sat)	_	TERM I	0.25 0.6	V
Base-Emitter Saturation Voltage (I _C = (I _C =	= 10 mA, I _B = 0.5 mA) = 100 mA, I _B = 5.0 mA)	V _{BE(sat)}		0.7 0.9		V
Base-Emitter Voltage (I _C = 2.0 mA, V _{CE} = 5.0 V) (I _C = 10 mA, V _{CE} = 5.0 V)		V _{BE(on)}	580	660	700 770	mV
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain Bandwidth Product $(I_C = 10 \text{ mA}, V_{CE} = 5.0 \text{ Vdc}, f = 1)$	00 MHz)	fT	100	-	-	MHz
Output Capacitance (V _{CB} = 10 V, f =	1.0 MHz)	C _{obo}		_	4.5	pF
Noise Figure (I _C = 0.2 mA, V _{CE} = 5.0 Vdc, R _S = 2.0 k Ω , f = 1.0 kHz, BW = 200 Hz)	BC846A, BC847A, BC848A BC846B, BC847B, BC848B BC847C, BC848C BC849A,B,C, BC850A,B,C	NF		_	10 4.0	dB

Rating	Symbol	BC856	BC857	BC858	Unit
Collector-Emitter Voltage	VCEO	-65	-45	-30	٧
Collector-Base Voltage	VCBO	-80	-50	-30	٧
Emitter-Base Voltage	VEBO	-5.0	-5.0	-5.0	٧
Collector Current — Continuous	Ic	-100	-100	-100	mAdd

THERMAL CHARACTERISITCS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

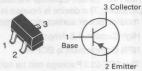
*FR-5 = $1.0 \times 0.75 \times 0.062$ in. **Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

DEVICE MARKING

BC856ALT1 = 3A; BC856BLT1 = 3B; BC857ALT1 = 3E; BC857BLT1 = 3F; BC857CLT1 = 3G; BC858ALT1 = 3J; BC858BLT1 = 3K; BC858CLT1 = 3L

BC856ALT1*, BLT1* BC857ALT1*, BLT1*, CLT1* BC858ALT1*, BLT1*, CLT1*

> **CASE 318-07, STYLE 6** SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

*These are Motorola designated preferred devices. Refer to BC556 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	Locarye		Bushin			
Collector-Emitter Breakdown Voltage (I _C = -10 mA)	BC856 Series BC857 Series BC858 Series	V _(BR) CEO	-65 -45 -30	ep <u>inl</u> ieV)	edici Enito edicionale	o v
Collector-Emitter Breakdown Voltage (I _C = -10 μA, V _{EB} = 0)	BC856 Series BC857 Series BC858 Series	V(BR)CES	-80 -50 -30		ivitu 2-otce	V
Collector-Base Breakdown Voltage (IC = -10μ A)	BC856 Series BC857 Series BC858 Series	V(BR)CBO	-80 -50 -30	2510 - Rora <u>na</u> Tem	svod a i tere Libra <u>io</u> nitus	v ao
Emitter-Base Breakdown Voltage (IE = -1.0μ A)	BC856 Series BC857 Series BC858 Series	V _{(BR)EBO}	-5.0 -5.0 -5.0	- BM	CE MARK	V
Collector Cutoff Current ($V_{CB} = -30 \text{ V}$) ($V_{CB} = -30 \text{ V}$, $T_{A} = 150^{\circ}\text{C}$)		ІСВО	STICE Non-IT-Amil	ARA <u>O</u> TER Ance = Janu	-15 -4.0	nA μA
ON CHARACTERISTICS		name most "	cae a onto	attion solder	ats secretal b	pal
DC Current Gain (I _C = $-10~\mu$ A, V _{CE} = $-5.0~\text{V}$) (I _C = $-2.0~\text{mA}$, V _{CE} = $-5.0~\text{V}$)	BC856A, BC857A, BC585A BC856A, BC857A, BC858A BC857C, BC858C BC856A, BC857A, BC858A	hFE I larked from a be	125	90 150 270	250	Di Di
	BC856B, BC857B, BC858B BC857C, BC858C		220 420	290 520	475 800	
Collector-Emitter Saturation Voltage ($I_C = -1$)	10 mA, $I_B = -0.5$ mA) 100 mA, $I_B = -5.0$ mA)	VCE(sat)	=	=	-0.3 -0.65	٧
Base-Emitter Saturation Voltage ($I_C = -10 \text{ n}$) ($I_C = -100 \text{ m}$)	$mA, I_B = -0.5 mA)$ $mA, I_B = -5.0 mA)$	V _{BE} (sat)	=	-0.7 -0.9	Ξ	٧
Base-Emitter On Voltage (I _C = -2.0 mA, V_{CE} = -5.0 V) (I _C = -10 mA, V_{CF} = -5.0 V)		V _{BE(on)}	-0.6 -	=	-0.75 -0.82	٧
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain Bandwidth Product ($I_C = -10$ mA, $V_{CE} = -5.0$ Vdc, $f = 100$ N	MHz)	f _T	100	re Motocia re		MHz
Output Capacitance ($V_{CB} = -10 \text{ V}, f = 1.0 \text{ N}$	1Hz)	Cob	-	_	4.5	pF
Noise Figure (I _C = -0.2 mA, V _{CE} = -5.0 Vo f = 1.0 kHz, BW = 200 Hz)	dc, $R_S = 2.0 \text{ k}\Omega$,	NF	-	-	10	dB

PNP Silicon Epitaxial Transistor

This PNP Silicon Epitaxial transistor is designed for use in audio amplifier applications. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- High Current: 1.5 Amps
- NPN Complement is BCP56
- The SOT-223 Package can be soldered using wave or reflow. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
 Use BCP53T1 to order the 7 inch/1000 unit reel.
 Use BCP53T3 to order the 13 inch/4000 unit reel.



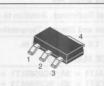
EMITTER

BASE 1

BCP53T1

Motorola Preferred Device

MEDIUM POWER PNP SILICON HIGH CURRENT TRANSISTOR SURFACE MOUNT



CASE 318E-04, STYLE 1 TO-261AA

MAXIMUM RATINGS (TC = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-80	Vdc
Collector-Base Voltage	VCBO	-100	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current	lc lc	1.5	Adc
Total Power Dissipation @ T _A = 25°C ⁽¹⁾ Derate above 25°C	PD	1.5 12 stoV myob/s	Watts mW/°C
Operating and Storage Temperature Range	TJ, T _{stg}	-65 to 150	°C

DEVICE MARKING

AH

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)	R ₀ JA	83.3	°C/W
Lead Temperature for Soldering, 0.0625" from case Time in Solder Bath	TL	260	°C
	AT BEDS ABSSON	10	Sec

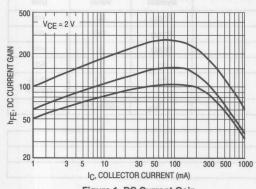
^{1.} Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 sq. in.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Тур	Max	Unit
DFF CHARACTERISTICS				2020	5,000
Collector-Base Breakdown Voltage (I _C = -100 μAdc, I _E = 0)	V(BR)CBO	-100	The state of	FILLE	Vdc
Collector-Emitter Breakdown Voltage ($I_C = -1.0 \text{ mAdc}$, $I_B = 0$)	V(BR)CEO	-80	ISHI	I SEXT	Vdc
Collector-Emitter Breakdown Voltage ($I_C = -100 \mu Adc$, $R_{BE} = 1.0 kohm$)	V(BR)CER	-100	Endonial	Solida Mai	Vdc
Emitter-Base Breakdown Voltage (I _E = -10 μAdc, I _C = 0)	V(BR)EBO	-5.0	pive u e nT	anolite oligo	Vdc
Collector-Base Cutoff Current ($V_{CB} = -30 \text{ Vdc}$, $I_E = 0$)	ІСВО	Thu <u>ni</u> n go	hus tewoo	-100	nAdo
Emitter-Base Cutoff Current (V _{EB} = -5.0 Vdc, I _C = 0)	IEBO		gm	-10	μAdo
ON CHARACTERISTICS	er no evaler gries	Districtions	eg maa ege 5. seeste la	MORU 6.3371	OE SIN
DC Current Gain ($I_C = -5.0$ mAdc, $V_{CE} = -2.0$ Vdc) ($I_C = -150$ mAdc, $V_{CE} = -2.0$ Vdc) ($I_C = -500$ mAdc, $V_{CE} = -2.0$ Vdc)	hFE Isas Mu	25 40 25	Tape and order the	250 —	ger m b IdellavA Idellav
Collector-Emitter Saturation Voltage (I _C = -500 mAdc, I _B = -50 mAdc)	VCE(sat)	_	Transa	-0.5	Vdc
Base-Emitter On Voltage ($I_C = -500 \text{ mAdc}$, $V_{CE} = -2.0 \text{ Vdc}$)	V _{BE(on)}	-	-	-1.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = -10 mAdc, V _{CE} = -5.0 Vdc, f = 35 MHz)	fT	-	50	-	MHz

TYPICAL ELECTRICAL CHARACTERISTICS



20 L 100 IC, COLLECTOR CURRENT (mA)

Figure 1. DC Current Gain

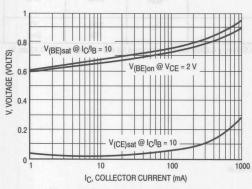


Figure 2. Current Gain Bandwidth Product

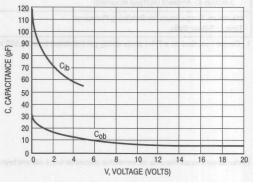


Figure 3. Saturation and "ON" Voltages

Figure 4. Capacitances

NPN Silicon Epitaxial Transistor

These NPN Silicon Epitaxial transistors are designed for use in audio amplifier applications. The device is housed in the SOT-223 package, which is designed for medium power surface mount applications.

- High Current: 1.0 Amp
- The SOT-223 package can be soldered using wave or reflow. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
 Use BCP56T1 to order the 7 inch/1000 unit reel
 Use BCP56T3 to order the 13 inch/4000 unit reel

PNP Complement is BCP53T1

2,4 COLLECTOR

1 BASE

3 EMITTER

BCP56T1 SERIES

Motorola Preferred Dev

MEDIUM POWER NPN SILICON HIGH CURRENT TRANSISTORS SURFACE MOUNT



CASE 318E-04, STYLE 1 TO-261AA

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	80	Vdc
Collector-Base Voltage	VCBO	100	Vdc
Emitter-Base Voltage	VEBO	5	Vdc
Collector Current	lc	1	Adc
Total Power Dissipation @ T _A = 25°C(1) Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Temperature Range	TJ, T _{stg}	-65 to 150	°C

DEVICE MARKING

BCP56T1 = BH	
BCP56-10T1 = BK	
BCP56-16T1 = BL	The state of the s

THERMAL CHARACTERISTICS

Thermal Resistance Junction-to-Ambient (surface mounted)	R _θ JA	83.3	°C/W
Maximum Temperature for Soldering Purposes	TL	260	°C
Time in Solder Bath		10	Sec

^{1.} Device mounted on a FR-4 glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.0625 in.; mounting pad for the collector lead = 0.93 sq. in.

Preferred devices are Motorola recommended choices for future use and best overall value.

Characteristics		Symbol	Min	Тур	Max	Unit
FF CHARACTERISTICS						1000
Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0)		V(BR)CBO	100	3°58) = (Vdc
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	- 1111	V(BR)CEO	80	7		Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)		V(BR)EBO	5.0	2/88	-	Vdc
Collector-Base Cutoff Current (V _{CB} = 30 Vdc, I _E = 0)		ІСВО			100	nAdc
Emitter-Base Cutoff Current (VEB = 5.0 Vdc, I _C = 0)		I _{EBO}			10	μAdc
N CHARACTERISTICS (2)	001		01			TOTAL
DC Current Gain $(I_C = 5.0 \text{ mA, V}_{CE} = 2.0 \text{ V})$ $(I_C = 150 \text{ mA, V}_{CE} = 2.0 \text{ V})$ $(I_C = 500 \text{ mA, V}_{CE} = 2.0 \text{ V})$	All Part Types BCP56T1 BCP56-10T1 BCP56-16T1 All Types	hFE	25 40 63 100 25	=======================================	250 160 250	
Collector-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc)		VCE(sat)			0.5	Vdc
Base-Emitter On Voltage (I _C = 500 mAdc, V _{CE} = 2.0 Vdc)		V _{BE(on)}		#=1	1.0	Vdc
DYNAMIC CHARACTERISTICS	111111111111111111111111111111111111111					l labo
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 35	5 MHz)	fτ	171	130		MHz

^{2.} Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

TYPICAL ELECTRICAL CHARACTERISTICS

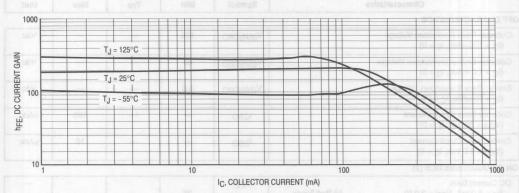


Figure 1. DC Current Gain

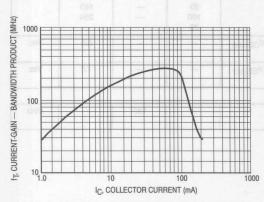


Figure 2. Current-Gain — Bandwidth Product

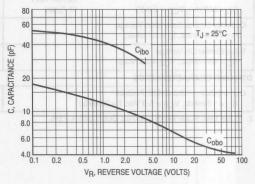


Figure 3. Capacitance

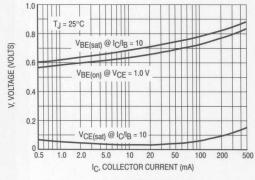


Figure 4. "On" Voltages

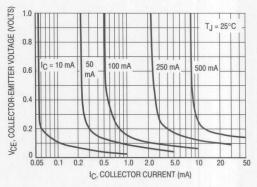


Figure 5. Collector Saturation Region

NPN Silicon Epitaxial Transistor

This NPN Silicon Epitaxial Transistor is designed for use in low voltage, high current applications. The device is housed in the SOT-223 package, which is designed for medium power surface mount applications.

- High Current: IC = 1.0 Amp
- The SOT-223 Package can be soldered using wave or reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
 Use BCP68T1 to order the 7 inch/1000 unit reel.
 Use BCP68T3 to order the 13 inch/4000 unit reel.

• The PNP Complement is BCP69T1

2,4 COLLECTOR

1
BASE
3 EMITTER

BCP68T1

Motorola Preferred Device

MEDIUM POWER NPN SILICON HIGH CURRENT TRANSISTOR SURFACE MOUNT



CASE 318E-04, STYLE 1 TO-261AA

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	25	Vdc
Collector-Base Voltage	VCBO	20	Vdc
Emitter-Base Voltage	VEBO	5	Vdc
Collector Current	Ic	1	Adc
Total Power Dissipation @ T _A = 25°C(1) Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{stg}	-65 to 150	°C

DEVICE MARKING

CA

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)	R ₀ JA	83.3	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	TL	260 10	°C Sec

^{1.} Device mounted on a FR-4 glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.0625 in.; mounting pad for the collector lead = 0.93 sq. in.

Preferred devices are Motorola recommended choices for future use and best overall value.

BCP68T1

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Тур	Max	Unit
FF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	V _(BR) CES	25	- (1		Vdc
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	V(BR)CEO	20	n sa <u>a a</u> lea a obsister? Isl	AND Editor	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V(BR)EBO	5.0	devic e i s noi er surface m	arii an otas medium pov	Vdc
Collector-Base Cutoff Current (V _{CB} = 25 Vdc, I _E = 0)	ІСВО	w onizu ben	Amp — can be sold	10	μAdc
Emitter-Base Cutoff Current (VEB = 5.0 Vdc, IC = 0)	IEBO	luser gallhu ables to rolls	ures level mo Visual Inspe	eme e10 Ages	μAdc
ON CHARACTERISTICS (2)	minating the poss	noldering, eli	granub asert	e lamiorit dio	ada abes
DC Current Gain (I _C = 5.0 mAdc, V _{CE} = 10 Vdc) (I _C = 500 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 Adc, V _{CE} = 1.0 Vdc)	hFE	50 85 60	isofLbris si fori Certine for Certini	0,0	vallable Vaq SC Vaq SC
Collector-Emitter Saturation Voltage (I _C = 1.0 Adc, I _B = 100 mAdc)	VCE(sat)	-	rT98408 el	0.5	Vdc
Base-Emitter On Voltage (I _C = 1.0 Adc, V _{CE} = 1.0 Vdc)	V _{BE(on)}	373		1.0	Vdc
DYNAMIC CHARACTERISTICS	(bal	on belimento e	seinu OrdS =	OTI SEMITAL	MUMIX
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 5.0 Vdc)	fT	golia	60	apatioV sattin	MHz

^{2.} Pulse Test: Pulse Width ≤ 300µs, Duty Cycle ≤ 2.0%.

TYPICAL ELECTRICAL CHARACTERISTICS

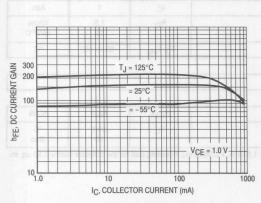


Figure 1. DC Current Gain

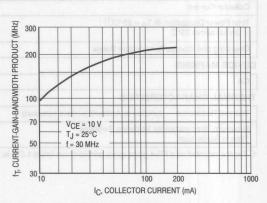


Figure 2. Current-Gain-Bandwidth Product

TYPICAL ELECTRICAL CHARACTERISTICS

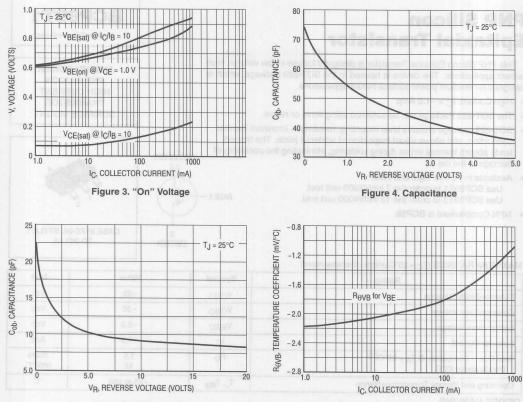


Figure 5. Capacitance

Figure 6. Base-Emitter Temperature Coefficient

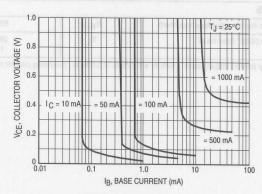


Figure 7. Saturation Region

PNP Silicon Epitaxial Transistor

This PNP Silicon Epitaxial Transistor is designed for use in low voltage, high current applications. The device is housed in the SOT-223 package, which is designed for medium power surface mount applications.

- High Current: I_C = −1.0 Amp
- The SOT-223 Package can be soldered using wave or reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die.
- Available in 12 mm Tape and Reel
 Use BCP69T1 to order the 7 inch/1000 unit reel.
 Use BCP69T3 to order the 13 inch/4000 unit reel.
- NPN Complement is BCP68



Motorola Preferred Device

MEDIUM POWER
PNP SILICON
HIGH CURRENT
TRANSISTOR
SURFACE MOUNT



EMITTER



CASE 318E-04, STYLE 1 TO-261AA

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-25	Vdc
Collector-Base Voltage	VCBO	-20	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current	Ic	-1.0	Adc
Total Power Dissipation @ T _A = 25°C ⁽¹⁾ Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{Stg}	-65 to 150	°C

DEVICE MARKING

CE

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)	R ₀ JA	83.3	°C/W
Lead Temperature for Soldering, 0.0625" from case Time in Solder Bath	TL	260	°C Sec

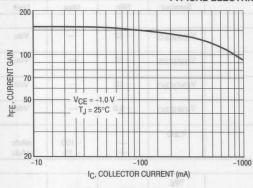
1. Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 sq. in.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics		1 5	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	JahV	-0.	F- 08	16 A		opsic	V ozs8-
Collector-Emitter Breakdown Voltage ($I_C = -100 \mu Ac$	dc, IE = 0)] (6	V(BR)CES	-25	7,000	nitre2 In	Vdc
Collector-Emitter Breakdown Voltage (I _C = -1.0 mAc	dc, I _B = 0)		V(BR)CEO	-20	20114	RET <u>OL</u> VER	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc$, I_C	= 0)	N	V(BR)EBO	-5.0	- 3	deha <u>m</u> nan	Vdc
Collector-Base Cutoff Current ($V_{CB} = -25 \text{ Vdc}$, $I_{E} =$	0)		ICBO	7 -	*,b1 <u>80</u> 8 8-1	-10	μAdc
Emitter-Base Cutoff Current ($V_{EB} = -5.0 \text{ Vdc}$, $I_{C} = 0.0 \text{ Vdc}$	O) gawan		IEBO	-	-	-10	μAdc
N CHARACTERISTICS	WAD:	8	38 6	in Rai	sidmA of au	fonut, cons	al Resist
DC Current Gain ($I_C = -5.0$ mAdc, $V_{CE} = -10$ Vdc) ($I_C = -500$ mAdc, $V_{CE} = -1.0$ Vdc) ($I_C = -1.0$ Adc, $V_{CE} = -1.0$ Vdc)	Wm OnWm WAS		hFE (50 85 60	0 = 2 in Ambe	375 —	e tre D suite Suite de above de idente
Collector-Emitter Saturation Voltage (I _C = -1.0 Adc, I _B = -100 mAdc)	0'	160	VCE(sat)	W.	вішвенер	-0.5	Vdc
Base-Emitter On Voltage (I _C = -1.0 Adc, V _{CE} = -1.0 Vdc)			V _{BE(on)}	.en m uls	86.08 IN 180.33	-1.0	Vdc
DYNAMIC CHARACTERISTICS						CINIC	E NIAR
Current-Gain — Bandwidth Product (I _C = -10 mAdc, V _{CE} = -5.0 Vdc)			fT	-	60	1; <u>ECP</u> V3Q1	MHz

TYPICAL ELECTRICAL CHARACTERISTICS



100 VCE = -10 V VCE = -10 V TJ = 25°C f = 30 MHz 100 C, COLLECTOR CURRENT (mA)

Figure 1. DC Current Gain

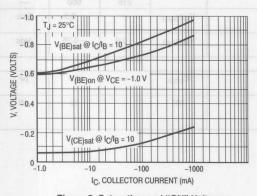


Figure 2. Current Gain Bandwidth Product

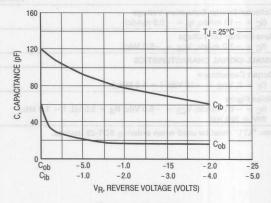


Figure 3. Saturation and "ON" Voltages

Figure 4. Capacitances

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-32	Vdc
Collector-Base Voltage	VCBO	-32	Vdc
Emitter-Base Voltage	V _{EBO}	-5.0	Vdc
Collector Current — Continuous	Ic	-100	mAdd

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	TJ, T _{sta}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BCW29LT1 = C1; BCW30LT1 = C2

BCW29LT1 BCW30LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N5086 for graphs.

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I _C = -2.0 mAdc, I _E = 0)	V(BR)CEO	-32		Vdc
Collector-Emitter Breakdown Voltage (I _C = -100 μAdc, V _{EB} = 0)	V(BR)CES	-32		Vdc
Collector-Base Breakdown Voltage (IC = -10μ Adc, IC = 0)	V(BR)CBO	-32		Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc$, $I_C = 0$)	V(BR)EBO	-5.0	S = { T -	Vdc
Collector Cutoff Current $(V_{CB} = -32 \text{ Vdc}, I_E = 0)$ $(V_{CB} = -32 \text{ Vdc}, I_E = 0, T_A = 100^{\circ}\text{C})$	ІСВО		- 100 - 10	nAdc μAdc
ON CHARACTERISTICS		01-		01=
DC Current Gain $(I_C = -2.0 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc})$ BCW29 BCW30	hFE nis 2 from	120 215	260 500	_

DC Current Gain (IC = -2.0 mAdc, VCE = -5.0 Vdc) BCW	Charleson, Account the	120 215	260 500	_
Collector-Emitter Saturation Voltage (I _C = -10 mAdc, I _B = -0.5 mAdc)	VCE(sat)	MITT	-0.3	Vdc
Base-Emitter On Voltage (I _C = -2.0 mAdc, V _{CE} = -5.0 Vdc)	VBE(on)	-0.6	-0.75	Vdc
SMALL-SIGNAL CHAPACTERISTICS				-

SIVIALL-SIGNAL CHARACTERISTICS				
Output Capacitance (I _E = 0, V _{CB} = -10 Vdc, f = 1.0 MHz)	C _{obo}	V 0.1 — 30V.0	7.0	pF
Noise Figure (I _C = -0.2 mAdc, V _{CE} = -5.0 Vdc, R _S = 2.0 k Ω , f = 1.0 kHz, BW = 200 Hz)	NF		10	dB

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

WATER TO THE TOTAL THE TOTAL TO THE TOTAL THE TOTAL TO THE TOTAL TOTAL TOTAL TO THE TOTAL TO THE TOTAL TO THE TOTAL TO THE TOTAL TOTAL TOTAL TO THE TOTAL TOTAL TOTAL TOTAL TO THE TOTAL TOTAL TO THE TOTAL TO					
Rating	Symbol	Value	Unit		
Collector-Emitter Voltage	VCEO	20	Vdc		
Collector-Base Voltage	V _{CBO}	30	Vdc		
Emitter-Base Voltage	VEBO	5.0	Vdc		
Collector Current — Continuous	Ic	100	mAdc		

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C

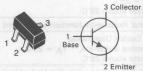
^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BCW31LT1 = D1; BCW33LT1 = D3

BCW33LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to MPS3904 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Charac	Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	Vippore			epetleV ave	Sins Drising	- Brotoelle
Collector-Emitter Breakdown Voltage (I _C = 2.0 mAdc, I _B = 0)	Vanauca		V(BR)CEO	32	i ≈ g⊫poAm awabaane s	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _B = 0)	220		V _(BR) CBO	32	I = (1 , i0Au Imeen A Han	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)			V _{(BR)EBO}	5.0	bbv 5 AT c6V 1	Vdc
Collector Cutoff Current (V _{CB} = 32 V, I _E = 0) (V _{CB} = 32 V, I _E = 0, T _A = 100 °C)	Caal		ІСВО	((100 10	nAdc μAdc
ON CHARACTERISTICS						
DC Current Gain (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc)		Abevida Boyvess	hFE	420	800	01 - 0 0
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 0.5 mAdc)		SOWERS	V _{CE} (sat)	_	0.25	Vdc
Base-Emitter On Voltage (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc)		SosW3e Closw3ii	V _{BE(on)}	0.55	0.70	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Output Capacitance (I _E = 0, V _{CB} = 10 Vdc, f = 1.0 MHz)		SCWS08	C _{obo}	(GDV 4).1	4.0	pF
Noise Figure (I _C = 0.2 mAdc, V _{CE} = 5.0 Vdc, R _S = f = 1.0 kHz, BW = 200 Hz)	2.0 kΩ	AGBWOB	NF	1 ,obV 0.8	10 neon	dB

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	32	V
Collector-Base Voltage	V _{CBO}	32	V
Emitter-Base Voltage	V _{EBO}	5.0	V
Collector Current — Continuous	Ic	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T _A = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{sta}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BCW60ALT1 = AA; BCW60BLT1 = AB; BCW60DLT1 = AD

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

BCW60ALT1 BCW60BLT1 BCW60DLT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to MPS3904 for graphs.

Ch	aracteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	Synsbul		nil attendanted	0		
Collector-Emitter Breakdown Voltage (I _C = 2.0 mAdc, I _E = 0)	Vissideo		V(BR)CEO	32	eokr <u>eu</u> ra I. Ider Breakd	Vdc
Emitter-Base Breakdown Voltage (I _E = 1.0 μ Adc, I _C = 0)	Vanheso		V(BR)EBO	5.0	e Bradkdow	Vdc
Collector Cutoff Current (VCE = 32 Vdc) (VCE = 32 Vdc, TA = 150°C)	овя(яв) ^У		ICES	o u afloV	20 20	nAdc μAdc
Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0)	osol		IEBO		20	nAdc
ON CHARACTERISTICS				F GUT " A	O m gl,V	CE = 80VI
DC Current Gain (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc)	guil	BCW60A BCW60B	hFE	20 30	BALLER PRODUCTION	0C Current C (I _C = 2.0 a
		BCW60D		100		res robellos
$(I_C = 2.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$		BCW60A BCW60B BCW60D		120 175 380	220	n 07 = 31) Pass Emitter 102 = 2.0
$(I_C = 50 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$		BCW60A BCW60B BCW60D	19	60 70 100	ARAHO JAI eopetis bV 01 = gc	
AC Current Gain ($I_C = 2.0 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$, f	= 1.0 kHz)	BCW60A BCW60B BCW60D	h _{fe}	125 175 350	250 350 700	(10 = 1.0 kHz) (10 = 1.0 kHz)
Collector-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 1.25 mAdc) (I _C = 10 mAdc, I _B = 0.25 mAdc)		5005	VCE(sat)	_	0.55 0.35	Vdc
Base-Emitter Saturation Voltage ($I_C = 50 \text{ mAdc}$, $I_B = 1.25 \text{ mAdc}$) ($I_C = 50 \text{ mAdc}$, $I_B = 0.25 \text{ mAdc}$)			VBE(sat)	0.7 0.6	1.05 0.85	Vdc
Base-Emitter On Voltage (IC = 2.0 mAdc, VCF = 5.0 Vdc)			V _{BE(on)}	0.6	0.75	Vdc

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

BCW60ALT1 BCW60BLT1 BCW60DLT1

Characteristic			Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS			The state of the s		no select or	ed series
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz)	abAm.	- 007-	fT	125	oO — Ingiri	MHz
Output Capacitance (V _{CE} = 10 Vdc, I _C = 0, f = 1.0 MHz)	meti	20.00	C _{obo}	EQ <u>II</u> almi	4.5	pF
Noise Figure (I _C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 k Ω , f = 1.0 kHz, BW = 200 Hz)	Vitra 27.Wm	225.	NF	brea T aliff	6.0	dB
SWITCHING CHARACTERISTICS	VAO:	888	Ary8 nei	imA at notion	ut, ornasaler	Planned Re
Turn-On Time (I _C = 10 mAdc, I _{B1} = 1.0 mAdc)	Wen	300	ed ton	0'85 = AT	150	ns ns
Turn-Off Time (IB2 = 1.0 mAdc, VBB = 3.6 Vdc, R ₁ = R ₂ = 5.0 k Ω R _L = 990 Ω)	1, WASA	2,4	toff	dinVs of noits	800	ns

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-32	V
Collector-Base Voltage	V _{CBO}	-32	V
Emitter-Base Voltage	V _{EBO}	-5.0	V
Collector Current — Continuous	Ic	-100	mAdd

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_{\hbox{$A$}} = 25^{\circ}\hbox{$C$}$	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BCW61BLT1 = BB; BCW61CLT1 = BC; BCW61DLT1 = BD

BCW61BLT1 BCW61CLT1 BCW61DLT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N5086 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = -2.0 \text{ mAdc}, I_B = 0$)		V(BR)CEO	-32		Vdc
Emitter-Base Breakdown Voltage ($I_E = -1.0 \mu Adc$, $I_C = 0$)		V(BR)EBO	-5.0		Vdc
Collector Cutoff Current (V _{CE} = -32 Vdc) (V _{CE} = -32 Vdc, T _A = 150 °C)		ICES	=	- 20 - 20	nAdc μAdc
ON CHARACTERISTICS					
DC Current Gain (I _C = $-10~\mu$ Adc, V _{CE} = $-5.0~\text{Vdc}$)	BCW61B BCW61C BCW61D	hFE	30 40 100		_
(I _C = -2.0 mAdc, V _{CE} = -5.0 Vdc)	BCW61B BCW61C BCW61D		140 250 380	310 460 630	
$(I_C = -50 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})$	BCW61B BCW61C BCW61D		80 100 100	=	
AC Current Gain (IC = -2.0 mAdc, VCE = -5.0 Vdc, f = 1.0 kHz)	BCW61A BCW61B BCW61C BCW61D	h _{fe}	125 175 250 350	250 350 500 700	
Collector-Emitter Saturation Voltage ($I_C = -50$ mAdc, $I_B = -1.25$ mAdc) ($I_C = -10$ mAdc, $I_B = -0.25$ mAdc)		V _{CE(sat)}	= -	- 0.55 - 0.25	Vdc
Base-Emitter Saturation Voltage ($I_C = -50$ mAdc, $I_B = -1.25$ mAdc) ($I_C = -10$ mAdc, $I_B = -0.25$ mAdc)		V _{BE(sat)}	-0.68 -0.6	- 1.05 - 0.85	Vdc
Base-Emitter On Voltage (I _C = -2.0 mAdc, V _{CE} = -5.0 Vdc)		V _{BE(on)}	-0.6	-0.75	Vdc

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

BCW61BLT1 BCW61CLT1 BCW61DLT1

FI FCTRICAL	CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS	-mArte	008	Ad I	Ruguella	or other and	O rotselli
Output Capacitance ($V_{CE} = -10 \text{ Vdc}$, $I_{C} = 0$, $f = 1.0 \text{ MHz}$)			C _{obo}	enarios	6.0	pF
Noise Figure $(I_C = -0.2 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc}, R_S = 2.0)$	$k\Omega$, $f = 1.0 \text{ kHz}$,	BW = 200 Hz)	NF	istje — FR-5 Board	6.0	dB
SWITCHING CHARACTERISTICS					1 3	$T_{A} = 25$
Turn-On Time (I _C = -10 mAdc, I _{B1} = -1.0 mAdc)	W/3°	088	ton	tina to Amt	150	ns
Turn-Off Time $(I_{B2} = -1.0 \text{ mAdc}, V_{BB} = -3.6 \text{ Vdc}, R_1 = R_2)$	= 5.0 kΩ, R _L =	990 Ω)	toff	$T_{A} = 28^{\circ}C$	800	ns

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	32	Vdc
Collector-Base Voltage	VCBO	60	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	Ic	800	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

DEVICE MARKING

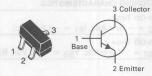
BCW65ALT1 = EA

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	V(BR)CEO	32	-	-	Vdc
Collector-Emitter Breakdown Voltage (I _C = 10 µAdc, V _{EB} = 0)	V(BR)CES	60		-	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	V(BR)EBO	5.0		-	Vdc
Collector Cutoff Current (VCE = 32 Vdc, I _E = 0) (VCE = 32 Vdc, I _E = 0, T _A = 150°C)	ICES	=	=	20 20	nAdo μAdo
Emitter Cutoff Current $(V_{EB} = 4.0 \text{ Vdc}, I_{C} = 0)$	IEBO	=	-	20	nAdc
ON CHARACTERISTICS				E MULTER	
DC Current Gain	hFE	35 75 100 35	=	220 250	-
Collector-Emitter Saturation Voltage (IC = 500 mAdc, I _B = 50 mAdc) (IC = 100 mAdc, I _B = 10 mAdc)	VCE(sat)	_	0.7 0.3	_	Vdc
Base-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc)	V _{BE} (sat)	-	_	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	fT	100	-	-	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	-	-	12	pF
Input Capacitance (VEB = 0.5 Vdc, IC = 0 , f = 1.0 MHz)	C _{ibo}	-		80	pF
Noise Figure (I _C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k Ω , f = 1.0 kHz, BW = 200 Hz)	NF		_	10	dB
SWITCHING CHARACTERISTICS					
Turn-On Time (I _{B1} = I _{B2} = 15 mAdc)	ton	-	_	100	ns
Turn-Off Time (IC = 150 mAdc, RL = 150 Ω)	toff			400	ns
11C - 150 made, nL = 150 11)					

BCW65ALT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

^{*}FR-5 = 1.0 x 0.75 x 0.062 in. **Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	-45	Vdc
Collector-Base Voltage	V _{CBO}	-60	Vdc
Emitter-Base Voltage	V _{EBO}	-5.0	Vdc
Collector Current — Continuous	Ic	-800	mAdd

THERMAL CHARACTERISITCS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	T _J , T _{sta}	-55 to +150	°C

DEVICE MARKING

BCW68GLT1 = DH

BCW68GLT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTOR

PNP SILICON

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS		Sessio	V myobilsen	E nettimil-	Collector
Collector-Emitter Breakdown Voltage $(I_C = -10 \text{ mAdc}, I_B = 0)$	V(BR)CEO	-45	(0 <u>=</u> gl ; / nwobiter	-2.0 <u>.1</u> nAd Smittle 8	Vdc
Collector-Emitter Breakdown Voltage (I _C = -10 μAdc, V _{EB} = 0)	V(BR)CES	-60	5 VE <u>a</u> = 0 down Valta	- 10 <u>0.</u> aAd Sase Erask	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc, I_C = 0$)	V(BR)EBO	-5.0	IC = _Ol	- 10 <u></u> Ada Cutoff Cu	Vdc
Collector Cutoff Current ($V_{CE} = -45 \text{ Vdc}$, $I_{E} = 0$) ($V_{CE} = -45 \text{ Vdc}$, $I_{B} = 0$, $T_{A} = 150^{\circ}\text{C}$)	ICES	(5/10 <u>m2</u> =	(0 = 3) (1 = 3) (1 = 3) (1 = 3)	-20 -10	nAdc μAdc
Emitter Cutoff Current (V _{EB} = -4.0 Vdc, I _C = 0)	IEBO	Tably 6:8	e e any s	-20	nAdc
ON CHARACTERISTICS	BCW26				
DC Current Gain ($I_C = -10 \text{ mAdc}$, $V_{CE} = -1.0 \text{ Vdc}$) ($I_C = -100 \text{ mAdc}$, $V_{CE} = -1.0 \text{ Vdc}$) ($I_C = -300 \text{ mAdc}$, $V_{CE} = -1.0 \text{ Vdc}$)	hFE	120 160 60	turation Vi.	400 —	00 <u>ll</u> ector = 30 m3-sen8 = 30
Collector-Emitter Saturation Voltage (I _C = -300 mAdc, I _B = -	30 mAdc) V _{CE(sat)}	-836	BREIT S ARA	-1.5	Vdc
Base-Emitter Saturation Voltage $(I_C = -500 \text{ mAdc}, I_B = -50 \text{ m})$	nAdc) VBE(sat)	_	-	-2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS		(sHM 0.7	- 10 Vda, f =	# 60V-I	1 = 30
Current-Gain — Bandwidth Product ($I_C = -20 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$, $f = 100 \text{ MHz}$)	fT .nu 0.2 =	100	- = 30V 2	gura - 0.2 mAd	MHz
Output Capacitance ($V_{CB} = -10 \text{ Vdc}$, $I_{E} = 0$, $f = 1.0 \text{ MHz}$)	C _{obo}		tast ous	18	pF
Input Capacitance ($V_{EB} = -0.5 \text{ Vdc}$, $I_{C} = 0$, $f = 1.0 \text{ MHz}$)	C _{ibo}	h Britispan	Date Date	105	pF
Noise Figure $\;$ (I $_{C}=-0.2$ mAdc, V $_{CE}=-5.0$ Vdc, R $_{S}=1.0$ kΩ, $f=1.0$ kHz, BW $=200$ Hz)	NF	-	-	10	dB

^{*}FR-5 = 1.0 x 0.75 x 0.062 in. **Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-45	Vdc
Emitter-Base Voltage	V _{EBO}	-5.0	Vdc
Collector Current — Continuous	Ic	-100	mAdc

THERMAL CHARACTERISITCS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** TA = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BCW69LT1 = H1; BCW70LT1 = H2

BCW69LT1 BCW70LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N5086 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Chara	acteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	lodmy#		oltation	14:50		
Collector-Emitter Breakdown Voltage (I _C = -2.0 mAdc, I _B = 0)	L Vancanty I		V _(BR) CEO	-45	ic redistros mitter Breeld	Vdc
Collector-Emitter Breakdown Voltage (I _C = -100μ Adc, V _{EB} = 0)	Vestors		V(BR)CES	-50	i di mA <u>rto, 1g</u> mitter Brestot	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc, I_C = 0$)	hearany		V(BR)EBO	-5.0	O "A <u>Ale</u> , V _{EB} se Breakkriowe	Vdc
Collector Cutoff Current ($V_{CB} = -20$ Vdc, $I_E = 0$) ($V_{CB} = -20$ Vdc, $I_E = 0$, $T_A = 100^{\circ}$ C	lees (ІСВО	(0 	-100 -10	nAdc μAdc
ON CHARACTERISTICS			(01)	0, TA = 19	- 45 Vds, 1g. =	- 809)
DC Current Gain $(I_C = -2.0 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc})$	BCV BCV		hFE	120 215	260 500	miller Cu (Veg = IN CHARA
Collector-Emitter Saturation Voltage (I _C = -10 mAdc, I _B = -0.5 mAdc)	394		VCE(sat)	= -1.0 Vo	-0.3	Vdc
Base-Emitter On Voltage (I _C = -2.0 mAdc, V _{CE} = -5.0 Vdc)			V _{BE(on)}	-0.6	-0.75	Vdc
SMALL-SIGNAL CHARACTERISTICS	VCELEBI	Ade, ig = - 30 nsAde)	10 = -300 m	ion Valtage	mitter Setural	i-nomella
Output Capacitance (I _E = 0, V _{CB} = -10 Vdc, f = 1.0 MH:	VBE(nat)	t lg = -50 mAde)	C _{obo}	Oli Parillo V SOTEMBTO	7.0	pF
Noise Figure (I _C = -0.2 mAdc, V _{CE} = -5.0 Vdc, F f = 1.0 kHz, BW = 200 Hz)	$R_S = 2.0 \text{ k}\Omega$,		NF	lin Product = -10 Vds	n — 10 pdwle 10 mAec, Vgr	

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	45	Vdc
Collector-Base Voltage	V _{CBO}	50	Vdc
Emitter-Base Voltage	V _{EBO}	5.0	Vdc
Collector Current — Continuous	Ic	100	mAdo

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stq}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BCW72LT1 = K2

BCW72LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to MPS3904 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Character	ristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS		f before selwha	- 26°C sudans off	ATI SOIT	RACTERIS	AHD JASI	нговыя
Collector-Emitter Breakdown Voltage (I _C = 2.0 mAdc, V _{EB} = 0)	Symbol		V(BR)CEO	45	-	- Berras	Vdc
Collector-Emitter Breakdown Voltage (I _C = 2.0 mAdc, V _{EB} = 0)	Vівпусво	er revole	V(BR)CES	45	alctown Ve	Smitter Bro	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0)	ana many	BCX18, 26	V _{(BR)CBO}	50		-	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	Sauman	BCX17, 19 BCX18, 20	V(BR)EBO	5.0	-(0 -	gi a m lu 0	Vdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) (V _{CB} = 20 Vdc, I _E = 0, T _A = 100°C)	loso		ІСВО	15070	ins = 10 = = AT-0 =	100 10	nAdc μAdc
ON CHARACTERISTICS					20	atolt Curren	O ratilmi
DC Current Gain (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc)			hFE	200	(0 = - 83)	450	SALID NO
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 0.5 mAdc) (I _C = 50 mAdc, I _B = 2.5 mAdc)	394		VCE(sat)	— (ab)	0.21	0.25	Vdc
Base-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 2.5 mAdc)	VCEleati		V _{BE} (sat)	= (ob)	0.85	6 magas, 4 Emitter Sep	Vdc
Base-Emitter On Voltage (IC = 2.0 mAdc, VCE = 5.0 Vdc)	(no)EEV		V _{BE} (on)	0.6	Arr <u>00</u> = g	0.75	Vdc
SMALL SIGNAL CHARACTERISTICS				(pb)	CE = 1,0 V	V shakm 00	9 - 50
Current-Gain — Bandwidth Product $(I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc}, f = 100)$) MHz)		To To devices.	erwai <u>r</u> iwes ordering Si	300	ed feuch	MHz
Output Capacitance (I _E = 0, V _{CB} = 10 Vdc, f = 1.0 MHz)			C _{obo}	_	-	4.0	pF
Input Capacitance (I _E = 0, V _{CB} = 10 Vdc, f = 1.0 MHz)			C _{ibo}		9.0	-	pF
Noise Figure (I _C = 0.2 mAdc, V _{CE} = 5.0 Vdc, R _S = f = 1.0 kHz, BW = 200 Hz)	2.0 kΩ,		NF	-	-	10	dB

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

		Va		
Rating	Symbol	BCX17LT1 BCX19LT1	BCX18LT1 BCX20LT1	Unit
Collector-Emitter Voltage	VCEO	45	25	Vdc
Collector-Base Voltage	VCBO	50	30	Vdc
Emitter-Base Voltage	VEBO	5.0		Vdc
Collector Current — Continuous	Ic	500		mAdd

THERMAL CHARACTERISTICS

Symbol	Max	Unit	
PD	225	mW	
	1.8	mW/°C	
$R_{\theta JA}$	556	°C/W	
PD	300	mW	
	2.4	mW/°C	
$R_{\theta JA}$	417	°C/W	
TJ, Tsta	-55 to +150	°C	
	PD R _θ JA PD R _θ JA	P _D 225 1.8 R _{θJA} 556 P _D 300 2.4 R _{θJA} 417	

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

PNP NPN BCX17LT1(1) BCX19LT1 BCX18LT1(1) BCX20LT1 3 Collector 3 Collector

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)

2 Emitter

2 Emitter



GENERAL PURPOSE TRANSISTORS

DEVICE MARKING

BCX17LT1 = T1; BCX18LT1 = T2; BCX19LT1 = U1; BCX20LT1 = U2

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Character	Symbol	Min	Тур	Max	Unit		
OFF CHARACTERISTICS					10 = 887	LUDENTI D.	7 4 01
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	V(88)CBO	BCX17, 19 BCX18, 20	V(BR)CEO	45 25	(0 = gg (a) awab	O mAde, Bapa Bree	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10 \mu Adc, I_C = 0$)	OBS(Ref)	BCX17, 19 BCX18, 20	V _(BR) CES	50 30		gricarus () okusii () 31 jain Asi ()	Vdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) (V _{CB} = 20 Vdc, I _E = 0, T _A = 150°C)	080		ІСВО	(22001	ent = 0 <u>1</u> = 0_T _A =	100 5.0	nAdc μAdc
Emitter Cutoff Current (V _{EB} = 5.0 Vdc, I _C = 0)			IEBO	-	838	10	μAdc
ON CHARACTERISTICS				(ata	V 0.8 = 80 V	DinAda, 1	8c = 2
DC Current Gain (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) (I _C = 300 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 1.0 Vdc)	VQE(sat)		hFE	100 70 40	ruration Vol. = 0 = mAc = 2 = mAc rion Voltage	600	Clic = 10 (lc = 1) (lc = 1) (lc = 1)
Collector-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc)	temsaaV		VCE(sat)	_ (a)	= 2 <u>E</u> mÅr	0.62	Vdc
Base-Emitter On Voltage (I _C = 500 mAdc, V _{CE} = 1.0 Vdc)			V _{BE(on)}	— (55) projec	V 0.3- 35	1.2	Vdc

⁽¹⁾ Voltage and current are negative for PNP transistors.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	45	Vdc
Collector-Base Voltage	VCBO	45	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	Ic	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit	
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW	
Derate above 25°C		1.8	mW/°C	
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W	
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300	mW/°C	
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W	
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C	

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BCX70GLT1 = AG; BCX70JLT1 = AJ; BCX70KLT1 = AK

BCX70GLT1 BCX70JLT1 BCX70KLT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to MPS3904 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 2.0 mAdc, I _E = 0)		V(BR)CEO	45	_	Vdc
Emitter-Base Breakdown Voltage (I _E = 1.0 µAdc, I _C = 0)		V(BR)EBO	5.0	-	Vdc
Collector Cutoff Current ($V_{CE} = 32 \text{ Vdc}$) ($V_{CE} = 32 \text{ Vdc}$, $T_{A} = 150^{\circ}\text{C}$)		ICES	Ξ	20 20	nAdc μAdc
Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0)		IEBO		20	nAdc
ON CHARACTERISTICS					
DC Current Gain (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc)	BCX70G BCX70J BCX70K	hFE	 40 100	=	_
$(I_C = 2.0 \text{ mAdc, V}_{CE} = 5.0 \text{ Vdc})$	BCX70G BCX70J BCX70K		120 250 380	220 460 630	
(I _C = 50 mAdc, V_{CE} = 1.0 Vdc)	BCX70G BCX70J BCX70K		60 90 100	=	
Collector-Emitter Saturation Voltage ($I_C = 50 \text{ mAdc}$, $I_B = 1.25 \text{ mAdc}$) ($I_C = 10 \text{ mAdc}$, $I_B = 0.25 \text{ mAdc}$)		V _{CE(sat)}	=	0.55 0.35	Vdc
Base-Emitter Saturation Voltage ($I_C = 50 \text{ mAdc}$, $I_B = 1.25 \text{ mAdc}$) ($I_C = 50 \text{ mAdc}$, $I_B = 0.25 \text{ mAdc}$)		V _{BE(sat)}	0.7 0.6	1.05 0.85	Vdc
Base-Emitter On Voltage (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc)		V _{BE(on)}	0.55	0.75	Vdc

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz)	DUMIN	402	fT	125	TOARAKO	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _C = 0, f = 1.0 MHz)	thit	xsM i	C _{obo}	— olta	4.5	pF
Small-Signal Current Gain (I _C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	D.Mu.	BCX70G BCX70J BCX70K	h _{fe}	125 250 350	250 500 700	TA = 25 Derato al Thermal Ro
Noise Figure $(I_C=0.2 \text{ mAdc}, V_{CE}=5.0 \text{ Vdc}, R_S=2.0 \text{ k}\Omega, f=1.0 \text{ kHz}, BW=200 \text{ Hz}$	Viens O'Wins	2.4	NF	T _A = zerc	6.0	dB
SWITCHING CHARACTERISTICS	11111	N/P	Aten rae	Idrae or note	not apastas	ad lemman
Turn-On Time (I _C = 10 mAdc, I _{B1} = 1.0 mAdc)	- 4	0011-0180-1-0	ton	imporature in	150	ns
Turn-Off Time (IB2 = 1.0 mAdc, VBB = 3.6 Vdc, R1 = R2 = 5.0 RL = 990 Ω)	ι κΩ,		toff	-35 11 12	800	ns

		obAn -

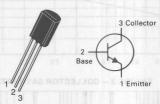
Rating	Symbol	BDB01C	BDB01D	Unit			
Collector-Emitter Voltage	VCEO	80	100	Vdc			
Collector-Base Voltage	VCES	80	100	Vdc			
Emitter-Base Voltage	VEBO	5	.0	Vdc			
Collector Current — Continuous	Ic	0.5		0.5		Adc	
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	1.0 8.0		Watt mW/°C			
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20		Watt mW/°C			
Operating and Storage Junction Temperature Range	TJ, T _{stg}	- 55 to	°C				

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°c/W
Thermal Resistance, Junction to Case	R_{θ} JC	50	°C/W

BDB01C,D

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



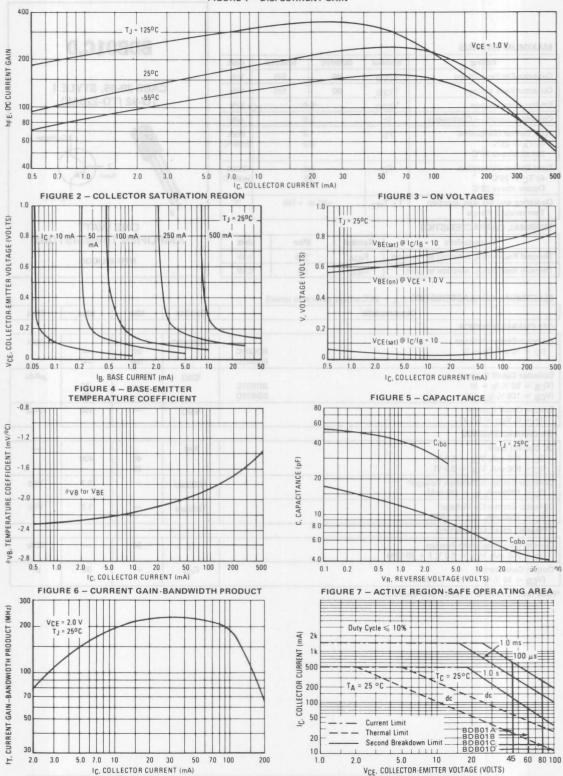
ONE WATT AMPLIFIER TRANSISTORS

NPN SILICON

	Symbol	Min	Max	Unit
	41114		144	
BDB01C BDB01D	V(BR)CEO	80 100		Vdc
BDB01C BDB01D	ICBO	ISE CURRENT I — BASE-EI LURIE COEF	.01 .01	μAdc
	IEBO		100	nAdc
3 1	hFE	40 25	400	1 2
on H-D	VCE(sat)		0.7	Vdc
3 1111	V _{BE(on)}		1.2	Vdc
				-14-4-13
	fT	50		MHz
908 305	C _{ob}	05 <u>10</u> 1 88108 0188	30	pF
	BDB01D BDB01C BDB01D	BDB01C BDB01D ICBO BDB01D IEBO VCE(sat) VBE(on)	BDB01C	BDB01C BDB01D ICBO

^{*}Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle 2.0%.





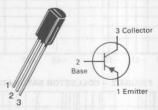
WAXIMUW RATINGS				
Rating	Symbol	BDB02C	BDB02D	Unit
Collector-Emitter Voltage	VCEO	-80	-100	Vdc
Collector-Base Voltage	VCES	-80	-100	Vdc
Emitter-Base Voltage	VEBO		5.0	Vdc
Collector Current — Continuous	Ic	-	0.5	Adc
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	1.0 8.0		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD		20	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to	o +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°c/W
Thermal Resistance, Junction to Case	ReJC	50	°C/W

BDB02C,D

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



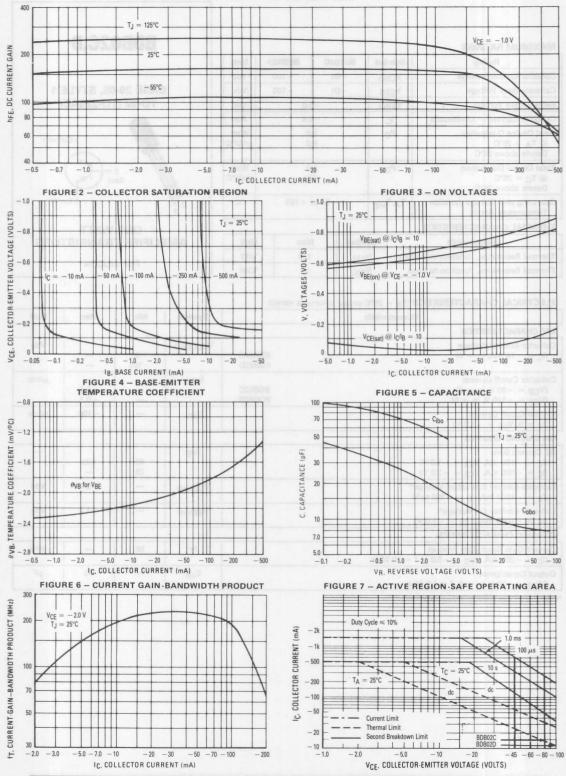
ONE WATT AMPLIFIER TRANSISTORS

PNP SILICON

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS				MI	MIL
Collector-Emitter Voltage $(I_C = -10 \text{ mA}, I_B = 0)$	BDB02C BDB02D	V(BR)CEO	-80 -100	1	Vdc
Collector Cutoff Current $(V_{CB} = -80 \text{ V, I}_{E} = 0)$ $(V_{CB} = -100 \text{ V, I}_{E} = 0)$	BDB02C BDB02D	ІСВО	4 - GASE-I STUR E COS	-0.1 -0.1	μAdc
Emitter Cutoff Current (IC = 0, VEB = -5.0 V)		IEBO		-100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I _C = -100 mA, V _{CE} = -1.0 V) (I _C = -500 mA, V _{CE} = -2.0 V)	A.	hFE	40 25	400	1 7
Collector-Emitter Saturation Voltage* (IC = -1000 mA, IB = -100 mA)		VCE(sat)		-0.7	Vdc
Collector-Emitter On Voltage* (IC = -1000 mA, VCE = -1.0 V)		V _{BE} (on)	-	-1.2	Vdc
DYNAMIC CHARACTERISTICS					THE RES
Current Gain Bandwidth Product (IC = -200 mA, $V_{CE} = -5.0$ V, f = 20 MHz	101 - 101	f _T	50	H - 11 -	MHz
Output Capacitance (V _{CB} = -10 V, I _E = 0, f = 1.0 MHz	TOUGIS	C _{ob}	MAUQ <u>E</u> OTSS MAD THE	30	pF

^{*}Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle 2.0%.





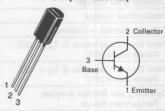
Rating	Symbol	BDC01D	Unit
Collector-Emitter Voltage	VCEO	100	Vdc
Collector-Base Voltage	Vсво	100	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	Ic	0.5	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

BDC01D

CASE 29-05, STYLE 14 TO-92 (TO-226AE)



ONE WATT
AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPSW05 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°c unless otherwise noted)

Cha	racteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				entransita.	SAME CHASE
Collector-Emitter Voltage (I _C = 10 mA, I _B = 0)	OBSIGNA)V	V _{(BR)CEO}	100	getto V tentre	Vdc
Collector Cutoff Current (V _{CB} = 100 V, I _E = 0)	papi	ІСВО	-	0.1	μAdc
Emitter Cutoff Current (I _C = 0, V _{EB} = 5.0 V)	088)	IEBO	- 10	100	nAdc
ON CHARACTERISTICS				SOUTH STO	OF ASSESSMENT
DC Current Gain (I _C = 100 mA, V_{CE} = 1.0 V) (I _C = 500 mA, V_{CE} = 2.0 V)	and	hFE	40 25	400	nonu u 30
Collector-Emitter Saturation Voltage* (I _C = 1000 mA, I _B = 100 mA)	VCE(sut)	VCE(sat)	nostioV not	0.7	Vdc
Collector-Emitter On Voltage* (IC = 1000 mA, VCE = 1.0 V)	(iso)38V	VBE(on)	Paget	1.2	Vdc
DYNAMIC CHARACTERISTICS			onero	BELTAKOAF	1 THE LINE
Current Gain Bandwidth Product (I _C = 200 mA, V_{CE} = 5.0 V, f = 20	MHz	f _T	50	Basswittl	MHz
Output Capacitance (V _{CB} = 10 V, I _E = 0, f = 1.0 MHz)	do ^O	C _{ob}		30	pF

^{*}Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle 2.0%.

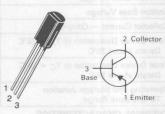
Rating	Symbol	BDC02D	Unit
Collector-Emitter Voltage	V _{CEO} -100		Vdc
Collector-Base Voltage	VCBO	-100	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current — Continuous	IC	-0.5	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	O° E

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	50	°C/W

BDC02D

CASE 29-05, STYLE 14 TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTOR

PNP SILICON

Refer to MPSW55 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°c unless otherwise noted)

Charac	cteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				GUITERATUR	VIPSIBA TER
Collector-Emitter Voltage (I _C = -10 mA, I _B = 0)	10(NB)V	V(BR)CEO	-100	iù = gl Am	Vdc
Collector Cutoff Current (V _{CB} = -100 V, I _E = 0)	989	ІСВО	-	-0.1	μAdc
Emitter Cutoff Current (I _C = 0, V _{EB} = -5.0 V)	089	I _{EBO}	-	-100	nAdc
ON CHARACTERISTICS				Self Charles	AUTHER 1
DC Current Gain $(I_C = -100 \text{ mA, V}_{CE} = -1.0 \text{ V})$ $(I_C = -500 \text{ mA, V}_{CE} = -2.0 \text{ V})$	374	hFE	40 25	400	0f = 30 0f = 30
Collector-Emitter Saturation Voltage* (I _C = -1000 mA, I _B = -100 mA)	sa)30 ^M	V _{CE(sat)}	iAm 001	-0.7	Vdc
Collector-Emitter On Voltage* (IC = -1000 mA, VCE = -1.0 V)	10]38V	VBE(on)	(V 0.7	-1.2	Vdc
DYNAMIC CHARACTERISTICS			60118	ING KAMPANI	JIMPART.
Current Gain Bandwidth Product $(I_C = -200 \text{ mA}, V_{CE} = -5.0 \text{ V}, f = 200 \text{ mA})$) MHz	fT _{s+tM} (50	= 33V Am (MHz
Output Capacitance	db-2	C _{ob}	sHM 0.r = 1	30	pF

 $⁽V_{CB} = -10 \text{ V}, I_E = 0, f = 1.0 \text{ MHz})$ *Pulse Test: Pulse Width $\leq 300 \mu s$, Duty Cycle 2.0%.

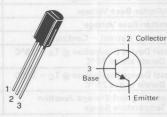
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	300	Vdc
Collector-Base Voltage	VCBO	300	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	Ic	500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 50	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

BDC05

CASE 29-05, STYLE 14 TO-92 (TO-226AE)



ONE WATT HIGH VOLTAGE TRANSISTOR

NPN SILICON

Refer to MPSW42 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°c unless otherwise noted)

Characteristic		an ssaid or an -	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	leamys		51481123.03	TIBITO!		
Collector-Emitter Breakdown Voltage (1) (I _C = 1.0 mAdc, I _B = 0)	V(BR)CEO	1	(BR)CEO	300	mitter Treate	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc, I_E = 0$)	Can(aa)Can	\	(BR)CBO	300	Rase Breakd	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μ Adc, I _C = 0)	O85(88)V	\	V(BR)EBO	5.0	ohote#18 nation	Vdc
Collector Cutoff Current (V _{CB} = 200 Vdc, I _E = 0)	Icao		ІСВО	10	0.01	μAdc
Emitter Cutoff Current (VEB = 5.0 Vdc, I _C = 0)			IEBO	- at	10 70	μAdc
ON CHARACTERISTICS				(ob// 01 =	Add, Vet	(tg = 7 c
DC Current Gain (I _C = 25 mAdc, V _{CE} = 20 Vdc)	(no)38V		hFE	40	ter Q=Velta nAdc,IVgs=	30 <u>4</u> -€mir 11g = 7
Collector-Emitter Saturation Voltage* (I _C = 20 mAdc, I _B = 2.0 mAdc)			VCE(sat)	LACTERIST Ith Product	2	Vdc
Base-Emitter Saturation Voltage (I _C = 20 mA, I _B = 2.0 mA)	esQ		V _{BE(sat)}	- 10 <u>W</u> g, 1 back Čapac	2.0	Vdc
DYNAMIC CHARACTERISTICS			(ZHIV	0.1=1.0	= 31 only m	- aby)
Current Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 20 N	1Hz	(s)41// (fT _{1,Q} o	60	A. Vee	MHz
Collector-Base Capacitance (V _{CB} = 30 Vdc, I _E = 0, f = 1.0 MHz)			C _{re}		2.8	pF

^{*}Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle 2.0%.

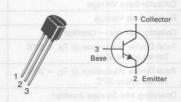
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	25 C	Vdc
Collector-Base Voltage	VCBO	40	Vdc
Emitter-Base Voltage	VEBO	4.0	Vdc
Collector Current - Continuous	Ic	100	mAdc
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-55 to +150	or ag °C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

BF199

CASE 29-04, STYLE 21 TO-92 (TO-226AA)



RF TRANSISTOR

NPN SILICON

Refer to BF240 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25 °C unless otherwise noted)

Charac	teristic	Symbol	Min.	Тур.	Max.	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I _C = 1 mAdc, I _B = 0)	030(86)*	V(BR)CEO	25	(0 =	il alsAm 0.	Vdc
Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0)	VIBRICED	V(BR)CBO	40	(6 =	al ,akku, 80	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)	OSS(SS)	V(BR)EBO	4	10 =	no patricular	Vdc
Collector Cutoff Current (VCB = 20 Vdc, IE = 0)	onol	ICBO		(0 =	100	nAdc
ON CHARACTERISTICS	063	ran Cutoff Cornent				O rettimi3
DC Current Gain (IC = 7 mAdc, VCE = 10 Vdc)		hFE	40	85	ACTEMBED A	EAHO MO
Base-Emitter On Voltage (IC = 7 mAdc, VCE = 10 Vdc)	Bail	VBE(on)		770	900	mVdc
SMALL-SIGNAL CHARACTERISTI	CS		*eps	station Voit	and huminos	-robstio0
Current Gain-Bandwidth Product ((IC = 5 mAdc, VCE = 10 Vdc, f =		fŢ	400	750	D mAde, ig	MHz
Common Emitter Feedback Capacit (VCB = 10 Vdc, IE = 0, f = 1.0 M		Cre		0.25	0.35	pF
Noise Figure (IC = 4 mA, VCE = 10 V, RS = 50) Ω, f = 35 MHz)	Nf	101	2.5	line il nis	dB

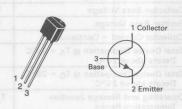
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	30	Vdc
Collector-Base Voltage	Vсво	45	Vdc
Emitter-Base Voltage	VEBO	4.0	Vdc
Collector Current - Continuous	IC	50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	R ₀ .IC	125	°C/W

BF224

CASE 29-04, STYLE 21 TO-92 (TO-226AA)



RF TRANSISTOR

NPN SILICON

Refer to BF240 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)

Characterist	ic Committee	Symbol	Min.	Тур.	Max.	Unit
OFF CHARACTERISTICS				6311	OINT EVAN	ATIVITE
Collector-Emitter Breakdown Voltage (IC = 1 mAdc, IB = 0)	OSCI(NB)V	V(BR)CEO	30	(0	gl ,sbAm	Vdc
Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0)	V(BR)CBQ	V(BR)CBO	45	(D =	10 gAdc 11	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)	OBB(NB)V	V(BR)EBO	4	(Q)	Di bygq (C	Vdc
Collector Cutoff Current (VCB = 20 Vdc, IE = 0)	T _A = 25 °C	ICBO		(0 =	100	nAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0)	39/1	IEBO		801	100	nAdc
ON CHARACTERISTICS				CAUN OI	SUN PURCH	1 7 7 7
DC Current Gain (IC = 7 mAdc, VCE = 10 Vdc)	(40)28,	hFE	30	10 V 01 = 30	O mAde, V	1 = 31)
Base-Emitter On Voltage (IC = 7 mAdc, VCE = 10 Vdc)	P I	VBE(on)	ta	0.77	0.9	mVdc
Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc)	970	VCE(sat)	ecitance	deg. spedpi	0.15	Vdc
SMALL-SIGNAL CHARACTERISTICS			EMBE D	1 - 1,0 -	31 CODE OL	- 80A)
Current Gain-Bandwidth Product (IC = 1.5 mAdc, V_{CE} = 10 Vdc, f = 100 (IC = 7 mAdc, V_{CE} = 10 Vdc, f = 100 N		f _T	300	600 850	Wealth 3	MHz
Common Emitter Feedback Capacitance (VCE = 10 Vdc, IE = 0, f = 1 MHz)		C _{re}		0.28		pF
Noise Figure $(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, R_S = 50)$	0 ohms, f = 100 MHz) f = 200 MHz	Nf		2.5 3.5		dB

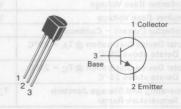
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	VCBO	40	Vdc
Emitter-Base Voltage	VEBO	4.0	Vdc
Collector Current - Continuous	IC	25	mAdc
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	Raic	125	°C/W

BF240

CASE 29-04, STYLE 21 TO-92 (TO-226AA)



AM/FM TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)

Characteristi	C Indame	Symbol	Min.	Тур.	Max.	Unit
OFF CHARACTERISTICS				ROUTS	NATIONAL PROPERTY.	AMO BR
Collector-Emitter Breakdown Voltage (1) (I _C = 1 mAdc, I _B = 0)	оззіявіУ	V(BR)CEO	40	/-mwoboles	Em tter E	Vrlc
Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0)	OBO(SB)V	V(BR)CBO	40	loV mwobil	Beal Sent	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μAdc, IC = 0)	088(88) ^A	V(BR)EBO	4	stroV nwet	doed Grank	Vdc
Collector Cutoff Current (VCB = 20 Vdc, IE = 0)	080	ІСВО		trieri 10 m	100	nAdc
ON CHARACTERISTICS						1
DC Current Gain (IC = 1 mAdc, VCE = 10 Vdc)		hFE	65	(0 = -	220	= 8 <u>34</u>)
Base-Emitter On Voltage (IC = 1.0 mAdc, VCE = 10 Vdc)	330	VBE(on)	0.65	0.70	0.74	Vdc
SMALL-SIGNAL CHARACTERISTICS	Total Control of the			anal.	Walley Control	ira-a asel
Current Gain-Bandwidth Product (IC = 1.0 mAdc, VCE = 10 Vdc, f = 100	MHz)	fŢ	ensti	600	gV.sbAm Sastania	MHz
Common Emitter Feedback Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz)		C _{re}	(at south)	0.28	0.34	pF

⁽¹⁾ Pulse test: Pulse Width \leqq 300 $\mu s.$ Duty cycle \leqq 2.0%.

FIGURE 1 - CURRENT GAIN-BANDWIDTH PRODUCT

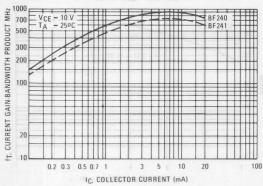


FIGURE 2 - CAPACITANCES

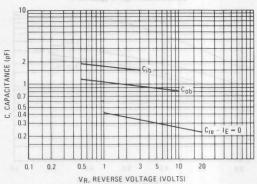


FIGURE 3 - DC CURRENT GAIN

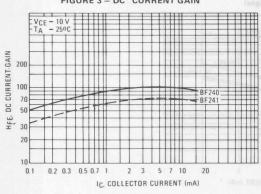


FIGURE 4 - b11e

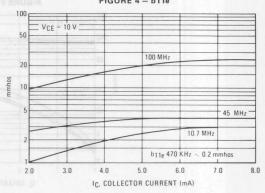


FIGURE 5 - b21e

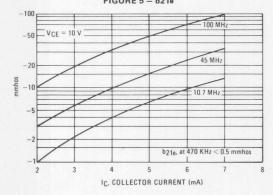
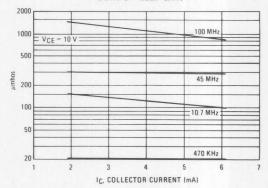
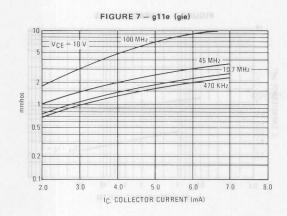
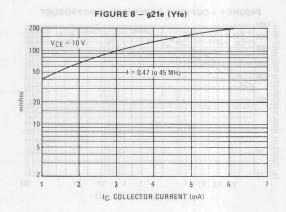
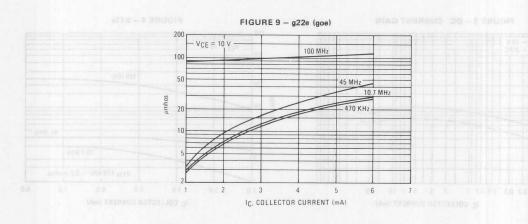


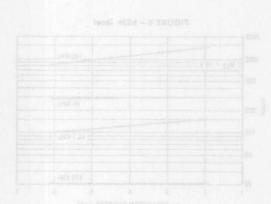
FIGURE 6 - b22e (boe)

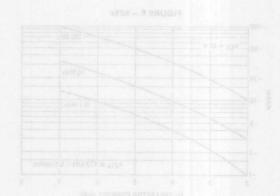












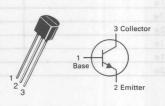
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	25	Vdc
Collector-Base Voltage	VCBO	30	Vdc
Emitter-Base Voltage	VEBO	3.0	Vdc
Collector Current - Continuous	IC	100	mAdc
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1:0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

BF374

CASE 29-04, STYLE 2 TO-92 (TO-226AA)



VHF TRANSISTOR

NPN SILICON

Refer to MPSH10 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25 °C unless otherwise noted)

Characteristic	Symbol	Min.	Тур.	Max.	Unit
OFF CHARACTERISTICS				10 P	
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	V(BR)CEO	25			Vdc
Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0)	V(BR)CBO	30			Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)	V(BR)EBO	3.0			Vdc
Collector Cutoff Current (VCB = 25 Vdc, IE = 0)	ICBO	(1984)	NOVEUMEN - 1	100	nAdc
Emitter Cutoff Current (VEB = 2.0 Vdc, I _C = 0)	IEBO	nami ser	manuro	100	nAdc
ON CHARACTERISTICS		Darwin to	sale former	31	
DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc)	hFE	70		250	
Collector-Emitter Saturation Voltage (IC = 1.0 mAdc, IB = 0.1 mAdc) (IC = 10 mAdc, IB = 1.0 mAdc)	VCE(sat)		50 70	Amir g	mVdc mVdc
Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	VBE(sat)		830		mVdc
Base-Emitter On Voltage (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc	VBE(on)		700 770		mVdc mVdc
SMALL-SIGNAL CHARACTERISTICS					137
Current Gain-Bandwidth Product (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	fT	400	800		MHz
Common Emitter Feedback Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	C _{re}		0.55	0.6	pF
Collector-Base Time Constant (IC = 4.0 mAdc, VCE = 10 Vdc, f = 31.8 MHz)	r _b C _c	(sHM) Y	6	8D EU	ps
Noise Figure (I _C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz, R_S = 50 ohms)	Nf		4		dB
Common-Emitter Amplifier Power Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 200 MHz)	Gpe		20		dB

ELECTRICAL CHARACTERISTICS (continued) (TA = 25 °C unless otherwise noted)

TYPICAL ADMITTANCE PARAMETERS (IC = 1.0 mAdc, VCE = 10 Vdc, frequency as stated)

Symbol	f = 10.7 MHz	f = 30 MHz	f = 100 MHz	Unit
G11e	0.28	0.4	1.4	mmho
B11e	0.6	1.6	5.0	mmho
G22e	6.5	7	20	μmho
B22e	0.1	0.3	1.0	mmho
G21e	36	34	30	mmho
B21e	- 0.8	- 2.5	- 9	mmho
B12e	- 52	- 150	- 500	μmho



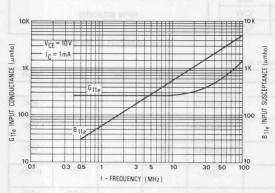


FIGURE 2 — OUTPUT ADMITTANCE
(Input short circuit)

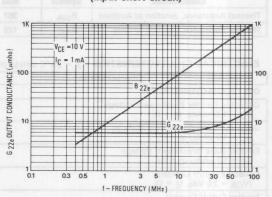
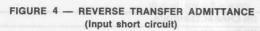
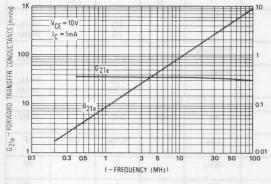
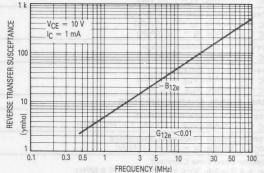


FIGURE 3 — FORWARD TRANSFER ADMITTANCE (Output short circuit)







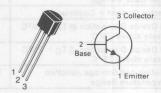
Rating S. S. A.	Symbol	BF 391	BF 392	BF 393	Unit
Collector-Emitter Voltage	VCEO	200	250	300	Vdc
Collector-Base Voltage	Vсво	200	250	300	Vdc
Emitter-Base Voltage	VEBO	0101/-	6.0		Vdc
Collector Current - Continuous	Ic	bAsi	500		mAdc
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	W/m 21.VA/n	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watt mW/°C	
Operating and Storage Junction Temperature Range	TJ, Tstg	- 55	-55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W

BF391 thru BF393

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to MPSA42 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)

tinti xeld nita Ch	aracteristic		V-1-10-10-10-10-10-10-10-10-10-10-10-10-1	Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS					301	TALHETOAR	AHO THO
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	e (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	BEAZE	BF391 BF392 BF393	V(BR)CEO	200 250 300	en8 valtim3 = gi_bAm	Vdc
Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0)	083(88)¥		BF391 BF392 BF393	V(BR)CBO	200 250 300	ar ob/ar 0.	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \mu Adc$, $I_C = 0$)	osol		BF391 BF392 BF393	V(BR)EBO	6.0 6.0 6.0	Curo <u>B</u> Cura 200 <u>V</u> dc. Iţ	Vdc
Collector Cutoff Current (VCB = 160 Vdc, IE = 0) (VCB = 200 Vdc, IE = 0) (VCB = 200 Vdc, IE = 0)	0831	DS.2448	BF391 BF392 BF393	ІСВО	= (0	0.1 · 0.1 · 0.1	μAdc
Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) (VEB = 6.0 Vdc, IC = 0) (VEB = 6.0 Vdc, IC = 0)	390		BF391 BF392 BF393	IEBO	= 2 0. Vdc)	0.1 0.1 0.1	μAdc
ON CHARACTERISTICS	VCE(set)			100	notion Volt	nac utinit	onello
DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc)	VBE(sat)		All Types All Types	hFE	25 40	forul—2 son Le g i Ani (ing-seet (bg = 2)
Collector-Emitter Saturation Volta ($I_C = 20 \text{ mAdc}$, $I_B = 2.0 \text{ mAdc}$)	ge			VCE(sat)	RACTERIS	2.0	Vdc
Base-Emitter Saturation Voltage (IC = 20 mA, IB = 2.0 mA)				VBE(sat)	= 10 Vdc. f	2.0	Vdc
SMALL SIGNAL CHARACTERIST	ICS			(51916)	0.1 = 1.0	= 31 salv 0E	Fyca =
Current-Gain - Bandwidth Production (IC = 10 mAdc, VCE = 20 Vdc, f	The state of the s		an 0.3	a, DuTTOyor Is	50	VV-02-09 -11	MHz
Common Emitter Feedback Capaci (VCB = 60 Vdc, IE = 0, f = 1.0 M				C _{re}		2.0	pF

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

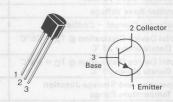
Rating	Symbol	BF 420	BF 422	Unit
Collector-Emitter Voltage	VCEO	300	250	Vdc
Collector-Base Voltage	Vсво	300	250	Vdc
Emitter-Base Voltage	VEBO	5.0		Vdc
Collector Current - Continuous	Ic	50	500	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD		625 5.0	
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W

BF420 BF422

CASE 29-04, STYLE 14 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to MPSA42 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25 °C unless otherwise noted)

Characteristic		Symbol	Min.	Max.	Unit	
OFF CHARACTERISTICS			- 23	RACTERIST	AHO 49	
Collector-Emitter Breakdown Voltage (1) (I _C = 1 mAdc, I _B = 0)	BF420 BF422	V(BR)CEO	300 250	e gl abAm b	Vdc	
Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0)	BF420 BF422	V(BR)CBO	300 250	tolografi ozadi gli , bo u, oc	Vdc	
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)	BF420 BF422	V(BR)EBO	5.0 5.0	obale - 2 ene	Vdc	
Collector Cutoff Current (V _{CB} = 200 Vdc, I _E = 0)	BF420 BF422	ICBO	- 10	0.01	μAdo	
Emitter Cutoff Current (V _{EB} = 5.0 Vdc, I _C = 0)	BF420 BF422	IEBO	(0 = (0 =	100	nAdd	
ON CHARACTERISTICS				Incarred Both	O retifier	
DC Current Gain (I _C = 25 mAdc, V _{CE} = 20 Vdc)	BF420 BF422	hFE	50 50	4.0 Vdb. lg = 6.0 V dc . lg = 6.0 Vdc. lg =	= 83 11 - 83VI - 83VI	
Collector-Emitter Saturation Voltage (IC = 20 mAdc, IB = 2.0 mAdc)		VCE(sat)	83	0.5	Vdc	
Base-Emitter Saturation Voltage (IC = 20 mA, IB = 2.0 mA)	All Types All Types	VBE(sat)	(abV OT =)	2.0	Vdc	
SMALL SIGNAL CHARACTERISTICS		696	dteV neiter	Emittei Satu	arvinallo	
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 20 MHz)		fŢ	60) mestip, light their Ta rupath	MHz	
Common Emitter Feedback Capacitance (VCB = 30 Vdc, IE = 0, f = 1.0 MHz)		Cre	D mA)	1.6	pF	

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

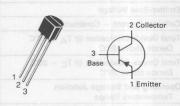
Rating	Symbol	BF 421	8464	BF 423	Unit
Collector-Emitter Voltage	VCEO	-300	008	- 250	Vdc
Collector-Base Voltage	VCBO	-300	036-	- 250	Vdc
Emitter-Base Voltage	VEBO	abV	-5.0	0.0-	Vdc
Collector Current — Continuous	IC	abAm	-500	-600	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	VVm OCVVm	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	meW/	1.5 12	1.6	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-58	5 to +	150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta,JC}$	83.3	°C/W

BF421 BF423

CASE 29-04, STYLE 14 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

PNP SILICON

Refer to MPSA92 for graphs.

ELECTRICAL CHARACTERISTICS T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit		
OFF CHARACTERISTICS							
Collector-Emitter Breakdown Voltage ($I_C = -1.0 \text{ mAdc}, I_B = 0$)	(1) ₀₃₀₍₈₃₎ V	EF462	BF421 BF423	V(BR)CEO	-300 -250	Interdited and a	Vdc
Collector-Base Breakdown Voltage ($I_C = -100 \mu Adc, I_E = 0$)	VIBRICEO	185462 85493	BF421 BF423	V(BR)CBO	-300 -250	oo Brenkdow 10 pa <u>400</u> , lg =	Vdc
Emitter-Base Breakdown Voltage (I _E = -100μ Adc, I _C = 0)	V(ак)вао	BF452	BF421 BF423	V(BR)EBO	- 5.0 - 5.0	Brenisłowai O "sA ro , ig s	Vdc
Collector Cutoff Current (V _{CB} = -200 Vdc, I _E = 0)	0801	B7492	BF421 BF423	ІСВО	= (0 =	- 0.01 —	μAdc
Emitter Cutoff Current (V _{EB} = -5.0 Vdc, I _C = 0)	083	25492 85493	BF421 BF423	IEBO	= 60	-100 —	nAdc
ON CHARACTERISTICS						SOUTH PROPERTY OF	DARAHO M
DC Current Gain ($I_C = -25 \text{ mA}, V_{CE} = -20 \text{ Vdc}$)	390	Both Types	BF421 BF423	hFE	50 50	Judan LimAud, Voe mAud, Voe	(lg = -1
Collector-Emitter Saturation Voltage ($I_C = -20 \text{ mAdc}$, $I_B = -2.0 \text{ mAdc}$	VCE(881) (:			V _{CE(sat)}	on Voltage	-0.5	Vdc
Base-Emitter Saturation Voltage (I _C = -20 mA, I _B = -2.0 mA)	(me)38 ^V			V _{BE(sat)}	egeno'	-2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					annesar	DARAHA JEL	ADIZ-LIMM
Current-Gain — Bandwidth Product (I _C = -10 mAdc, V _{CE} = -10 Vdc,	, f = 20 MHz			f _T)	60	blwbrīst — apV sz Wm	MHz
Common Emitter Feedback Capacitar (V _{CB} = -30 Vdc, I _E = 0, f = 1.0 M				C _{re}	netto epe ctan	2.8	pF

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%

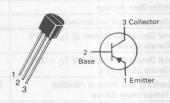
Rating	Symbol	BF492	BF493	Unit
Collector-Emitter Voltage	VCEO	-250	-300	Vdc
Collector-Base Voltage	VCBO	-250	-300	Vdc
Emitter-Base Voltage	VEBO	py -	6.0	Vdc
Collector Current - Continuous	IC	April - 5	500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD		25 .0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD		.5	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	- 55 to	+ 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

BF492 BF493

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

PNP SILICON

Refer to MPSA92 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Cha	racteristic			Symbol	Min	Max	Unit
OFF CHARACTERISTICS						BOH NETROY O	RECHARA
Collector-Emitter Breakdown Voltage ($I_C = -1.0 \text{ mAdc}, I_B = 0$)	1)0306881	BF421 BF423	BF492 BF493	V _(BR) CEO	- 250 - 300	e gli a <u>b</u> Am Q	Vdc
Collector-Base Breakdown Voltage $(I_C = -100 \ \mu Adc, I_E = 0)$	V(BR)CBO	BF421 BF423	BF492 BF493	V(BR)CBO	-250 -300	SK Stephoon 20 JA <u>d</u> o Jg v	Vdc
Emitter-Base Breakdown Voltage ($I_E = -100 \mu Adc, I_C = 0$)	OBS(SB)V	BF421 BF423	BF492 BF493	V _{(BR)EBO}	-6.0 -6.0	D Brasicowa 30 AAde. 1C	Vdc
Collector Cutoff Current (V _{CB} = -200 Vdc, I _E = 0) (V _{CB} = -200 Vdc, I _E = 0)	060)	BF421 BF423	BF492 BF493	ІСВО	_ 30 =	-0.1 -0.1	μAdc
Emitter Cutoff Current (VEB = -6.0 Vdc, I _C = 0) (VEB = -6.0 Vdc, I _C = 0)	oaal	BF421 BF423	BF492 BF493	IEBO	_ (0 -	-0.1 -0.1	μAdc
ON CHARACTERISTICS						SCHOOL STREET	ARAHO N
DC Current Gain (I _C = -1.0 mAdc, V _{CE} = -10 Vdc) (I _C = -10 mAdc, V _{CE} = 10 Vdc)	970	BP421 BP423	Both Types Both Types	hFE	25 40	mea apV_Am &	treament of
Collector-Emitter Saturation Voltage ($I_C = -20 \text{ mAdc}$, $I_B = -2.0 \text{ mAdc}$)	(tea) BDV			VCE(sat)	on Voltage -2,0 mAde	-2.0	Vdc
Base-Emitter Saturation Voltage $(I_C = -20 \text{ mA}, I_B = -2.0 \text{ mA})$				V _{BE(sat)}	Am 0,5	-2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					CONTRACTOR	JAHATSI JAM	DIG-JUAN
Current-Gain — Bandwidth Product $(I_C = -10 \text{ mAdc}, V_{CE} = -20 \text{ Vdc}, 1)$	= 20 MHz)			SHAPE - I	50	- Bandwid 1 mAdo, Vog	MHz
Common Emitter Feedback Capacitanc (V _{CB} = -100 Vdc, I _E = 0, f = 1.0 N				C _{re}	ck Capadicar 0, t = 1.0 K	1.6	pF

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

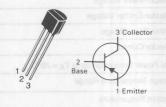
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-350	Vdc
Collector-Base Voltage	VCBO	-350	Vdc
Emitter-Base Voltage	VEBO	-6.0	Vdc
Collector Current — Continuous	Ic	-500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W

BF493S

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTOR

PNP SILICON

Refer to MPSA93 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	placents	Char		
Collector-Emitter Breakdown Voltage(1) (IC = -1.0 mAdc, I _B = 0)	V(BR)CEO	-350	еоттеказ	Vdc
Collector-Base Breakdown Voltage ($I_C = -100 \mu Adc$, $I_E = 0$)	V(BR)CBO	-350	$(0 = \overline{g} \downarrow, 00)A$	Vdc
Emitter-Base Breakdown Voltage (IE = -100μ Adc, IC = 0)	V(BR)EBO	-6.0	Adc, (E = 0)	Vdc
Collector Cutoff Current (V _{CE} = -250 Vdc)	ICES	e go rioV / (dol 1	-10	nAdc
Emitter Cutoff Current (VEB = -6.0 Vdc, I _C = 0)	I _{EBO}	9980	0.1	μAdc
Collector Cutoff Current ($V_{CB} = -250 \text{ Vdc}$, $I_E = 0$, $T_A = 25^{\circ}\text{C}$) ($V_{CB} = -250 \text{ Vdc}$, $I_E = 0$, $T_A = 100^{\circ}\text{C}$)	ІСВО	= 1	-0.005 -1.0	μAdc
ON CHARACTERISTICS		Ina	ter Culoff Cum	illector-Em
DC Current Gain (I _C = -1.0 mAdc, V _{CE} = -10 Vdc) (I _C = -10 mAdc, V _{CE} = -10 Vdc)	hFE	25 40	Wash year op a series of the s	VOE = 201 VCE = 201 MARACT
Collector-Emitter Saturation Voltage (I _C = -20 mAdc, I _B = -2.0 mAdc)	VCE(sat)	(ab)V	-2.0	Vdc
Base-Emitter On Voltage (I _C = -20 mA, I _B = -2.0 mA)	V _{BE} (sat)	ogatioV	-2.0	Vdc
DYNAMIC CHARACTERISTICS		55	arrosto da Trical	Wa alle
Current-Gain — Bandwidth Product ($I_C = -10 \text{ mAdc}$, $V_{CE} = -20 \text{ Vdc}$, $f = 20 \text{ MHz}$)	FT	50	- Bandwidth i	MHz
Common-Emitter Feedback Capacitance (V _{CB} = -100 Vdc, I _E = 0, f = 1.0 MHz)	C _{re}		1.6	pF

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	300	Vdc
Collector-Base Voltage	VCBO	300	Vdc
Collector-Emitter Voltage	VCER	300	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current	IC	100	mAdd
Total Power Dissipation up to T _A = 25°C	PD	1.5	Watts
Storage Temperature Range	T _{stg}	- 65 to +150	°C
Junction Temperature	TJ	150	°C

DEVICE MARKING

DC

THERMAL CHARACTERISTICS

Thermal Resistance from Junction to Ambient*	R ₀ JA	83.3	°C/W
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BF720T1*

CASE 318E-04, STYLE 1 (TO-261AA)

BASE 1

3

EMITTER



SOT-223 PACKAGE NPN SILICON TRANSISTOR SURFACE MOUNT

*This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted)

Chara	acteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	Visitoceo		(T) spenior in	HOUSE MAN TO THE	ind dotos
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	овзиямУ	V(BR)CEO	300	mwobusen6 o	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	oesine)y	V(BR)CBO	300	V mwotatau 6	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100 \mu Adc$, $R_{BE} = 2.7 k\Omega$)	loss	V(BR)CER	300	off Cul-ort 50 Vdc)	Vdc
Emitter-Base Breakdown Voltage $(I_E = 10 \mu Adc, I_C = 0)$	089	V(BR)EBO	5.0	Daniel (C = V	Vdc
Collector-Base Cutoff Current (V _{CB} = 200 Vdc, I _E = 0)	QE3 ¹	ІСВО	1. TA = 28°C)	10	nAdc
Collector-Emitter Cutoff Current		ICER		ENISTICS	CHARACO
$(V_{CE} = 250 \text{ Vdc}, R_{BE} = 2.7 \text{ k}\Omega)$ $(V_{CE} = 200 \text{ Vdc}, R_{BE} = 2.7 \text{ k}\Omega, T_{J} =$	150°C)		1007 01-	50 10	nAdc μAdc
ON CHARACTERISTICS			60V 01 -	any abAn	01- = 0
DC Current Gain (IC = 25 mAdc, VCE = 20 Vdc)	VCE(sat)	h _{FE}	50	olish <u>ra</u> R nelio nAde, Ig = -	613 1 <u>0,73</u> 0 65 = 5
Collector-Emitter Saturation Voltage (IC = 30 mAdc, IB = 5.0 mAdc)	(tes) 22 A	VCE(sat)	- fam (0.6	Vdc
DYNAMIC CHARACTERISTICS				TO THE PERSON NAMED IN	AL WHILE
Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 Vdc, f = 35	MHz)	f _{Tatrikir} os	60	= 90 V. stAm	MHz
Feedback Capacitance (V _{CE} = 30 Vdc, I _C = 0, f = 1.0 MHz)		C _{re}	shild on = 1.0	1.6	pF

^{*} Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 in².

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-300	Vdc
Collector-Base Voltage	VCBO	- 300	Vdc
Collector-Emitter Voltage	VCER	- 300	Vdc
Emitter-Base Voltage	VEBO	- 5.0	Vdc
Collector Current	Ic	- 100	mAdc
Total Power Dissipation up to T _A = 25°C*	PD*	1.5	Watts
Storage Temperature Range	T _{stg}	- 65 to +150	°C
Junction Temperature	TJ	150	°C

DEVICE MARKING

DF

THERMAL CHARACTERISTICS

Thermal Resistance from Junction to Ambient* R₀JA 83.3 °C/W

BF721T1*

CASE 318E-04, STYLE 1 (TO-261AA)





SOT-223 PACKAGE PNP SILICON TRANSISTOR SURFACE MOUNT

*This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Chara	acteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	050(8)7		Ya Joffey (O.A. V)	the of share	DESCAR
Collector-Emitter Breakdown Voltage (I _C = -1.0 mAdc, I _B = 0)	Yeshes	V(BR)CEO	- 300	obligation of the	Vdc
Collector-Base Breakdown Voltage (I _C = - 100 μAdc, I _E = 0)	раз(яв)У	V(BR)CBO	- 300	hwich T est or 0 - Teken	Vdc
Collector-Emitter Breakdown Voltage ($I_C = -100 \mu Adc, R_{BE} = 2.7 k\Omega$)	савияя)У	V(BR)CER	- 300	Brest <u>el</u> com 1 Aric, 1g = 0	Vdc
Emitter-Base Breakdown Voltage $(I_E = -10 \mu Adc, I_C = 0)$	0831	V(BR)EBO	- 5.0	0 3 Caurente 0 3 Caurente 0 Caurente	Vdc
Collector-Base Cutoff Current (V _{CB} = - 200 Vdc, I _E = 0)	nesi .	ICBO	- (6)	- 10	nAdc
Collector-Emitter Cutoff Current		ICER		0 Vdc, lc = 0	ag(v)
$(V_{CE} = -250 \text{ Vdc}, R_{BE} = 2.7 \text{ k}\Omega)$			-	-50	nAdc
$(V_{CE} = -200 \text{ Vdc}, R_{BE} = 2.7 \text{ k}\Omega, T_J = 100 \text{ M} \text{ M} \text{ M} \text{ M})$	150°C)			-10	μAdc
ON CHARACTERISTICS			Spirit I	= 30 / pour	V = 34
DC Current Gain (VCE = - 25 mAdc, VCE = - 20 Vdc)		hFE	50	= <u>ag</u> V _u bAn = agV _u bAn	(G +-)) RT R OF 1
Collector-Emitter Saturation Voltage (I _C = -30 mAdc, I _B = -5.0 mAdc)	(meladV	VCE(sat)	(f) serinoV o fabAm	- 0.8	Vdc
DYNAMIC CHARACTERISTICS			EDEPART.	and in the second	
Current-Gain — Bandwidth Product (VCE = - 10 Vdc, I _C = - 10 mAdc, f =	35 MHz)	f _T	60	V notimeta?	MHz
Feedback Capacitance (V _{CE} = - 30 Vdc, I _C = 0, f = 1.0 MHz)		C _{re}	etayā yau d jay 6	1.6	pF

^{*} Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 in².

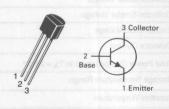
		10/10/1		
Rating	Symbol	Value	Unit	
Collector-Emitter Voltage	VCEO	400	Vdc	
Collector-Base Voltage	VCBO	450	Vdc	
Emitter-Base Voltage	VEBO	6.0	Vdc	
Collector Current — Continuous	Ic	300	mAdc	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C	
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C	
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150	°C	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W

BF844

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTOR

NPN SILICON

Refer to MPSA44 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characte	eristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	And middle	Alleinstein			
Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0)		V(BR)CEO	400	har Tinan	Vdc
Collector-Emitter Breakdown Voltage (I _C = 100 µAdc, V _{BE} = 0)	Y(BR)CEO	V(BR)CES	450	l = gl ,sitAm :	Vdc
Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0)	GGD(RB)V	V(BR)CBO	450	landol <u>di</u> s Blez Nagilipi Au G	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)	язојна)У	V(BR)EBO	6.0	obsko rti roda ocaR sobbu č	Vdc
Collector Cutoff Current (V _{CB} = 400 Vdc, I _E = 0)	083(86) ^V	ІСВО	. egallo	0.1	μAdc
Collector Cutoff Current (V _{CE} = 400 Vdc, V _{BE} = 0)	asot	ICES	168	500	nAdc
Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0)	and	IEBO	tnem	0.1	μAdc
ON CHARACTERISTICS			(0)73	# ENER JOHN C	2 -= 30V
DC Current Gain (1)	340	hFE	40 50 45 20	200	VOL SI CHARAC OCCURNIT (VCE
Collector-Emitter Saturation Voltage (1) $(I_C = 1.0 \text{ mAdc}, I_B = 0.1 \text{ mAdc})$ $(I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc})$ $(I_C = 50 \text{ mAdc}, I_B = 5.0 \text{ mAdc})$	VOE(set)	V _{CE(sat)}	n Vollage 6.0 n + (b) no5 =	0.4 0.5 0.75	Vdc
Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	7'	V _{BE(sat)}	LobAm 01	0.75	Vdc

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
DYNAMIC CHARACTERISTICS					DIRECTARIO	HANKA
High Frequency Current Gain (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 20 MHz)	fint	auteV	h _{fe}	1.0	entie ll	
Collector-Base Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 1.0 MHz)	98/	90	Cob	-	6.0	pF
Emitter-Base Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	Vac m\dc	0.8	C _{ib}	tinggara	110	pF
Turn-On Time (V _{CC} = 150 Vdc, V _{BE(off)} = 4.0 V,	3º/4/m	625 6.0	ton	@ Ta 28 V	0.6	μs
I _C = 30 mAdc, I _{B1} = 3.0 mAdc)	11639/	1.5	09 - 1	@1c = 28	soirequel d	tat Device
Turn-Off Time $(V_{CC} = 150 \text{ Vdc}, I_C = 30 \text{ mAdc}, I_{B1} = I_{B2} = 3.0 \text{ mAdc})$	mAdc)		toff	nonson	10	μs



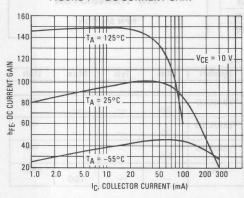
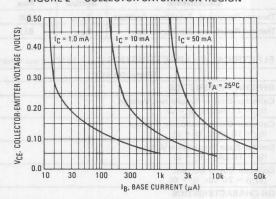


FIGURE 2 — COLLECTOR SATURATION REGION

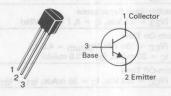


Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	20	Vdc
Collector-Base Voltage	VCBO	30	Vdc
Emitter-Base Voltage	VEBO	3.0	Vdc
Collector Current - Continuous	IC	100	mAdc
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

CASE 29-04, STYLE 21 TO-92 (TO-226AA)

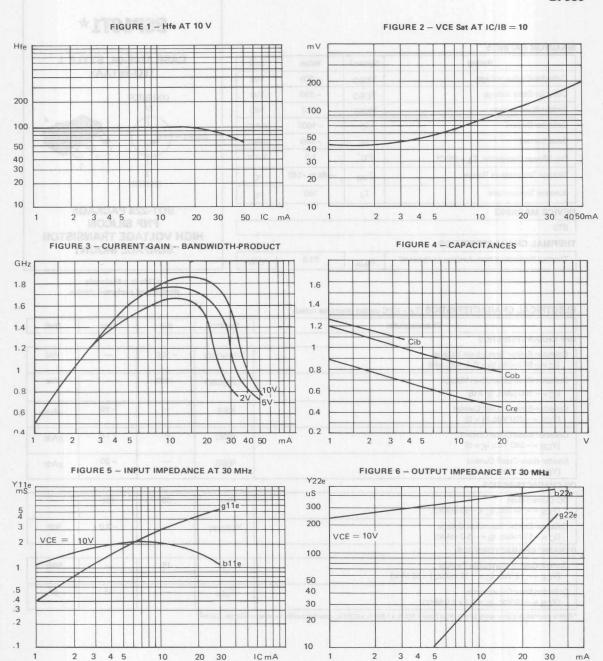


VHF TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)

Characteristic	Symbol	Min.	Тур.	Max.	Unit
OFF CHARACTERISTICS		TO THE		HILL	1001
Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0)	V(BR)CEO	20	- 11 2°8s	MALE	Vdc
Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0)	V(BR)CBO	30		_	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0)	V(BR)EBO	3.0	7-62-		Vdc
Collector Cutoff Current (VCB = 20 Vdc, IE = 0)	ІСВО	101 08	10 20	100	nAdc
ON CHARACTERISTICS		hours are mark	A THE WALLEY		
DC Current Gain (I _C = 5 mAdc, V _{CE} = 10 Vdc) (I _C = 20 mAdc, V _{CE} = 10 Vdc)	hFE	35 40	=	=	
Collector-Emitter Saturation Voltage (I _C = 30 mAdc, I _B = 2.0 mAdc)	VCE(sat)	_		1.0	Vdc
Base-Emitter Saturation Voltage (I _C = 30 mAdc, I _B = 2.0 mAdc)	VBE(sat)	_		1	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain – Bandwidth Product (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) (I _C = 30 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	ft	700 600	=	=	MHz
Common Emitter Feedback Capacitance (VCB = 10 Vdc, Pf = 0, f = 10 MHz)	C _{re}		0.65'	_	pF
Noise Figure (I _C = 4 mA, V_{CE} = 10 V, R_S = 50 Ω , f = 200 MHz)	Nf	_	3	_	dB



Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	- 300	Vdc
Collector-Base Voltage	VCBO	- 350	Vdc
Emitter-Base Voltage	VEBO	-6.0	Vdc
Collector Current	IC	- 1000	mAdd
Base Current	IB	- 500	mAdd
Total Power Dissipation, T _A = 25°C*	PD*	1.5	Watts
Storage Temperature Range	T _{stg}	- 65 to +150	°C
Junction Temperature	TJ	150	°C

DEVICE MARKING

BT2

THERMAL CHARACTERISTICS

Thermal Resistance from Junction to Ambient*	R ₀ JA	83.3	°C/W
	OUA		

BSP16T1*

CASE 318E-04, STYLE 1 (TO-261AA)





SOT-223 PACKAGE
PNP SILICON
HIGH VOLTAGE TRANSISTOR
SURFACE MOUNT

*This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
FF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = -50 mAdc, I _B = 0, L = 25 mH)	- an H	V _(BR) CEO	- 300		Vdc
Collector-Base Breakdown Voltage (I _C = – 100 μAdc, I _E = 0)	30	V _(BR) CBO	- 300	-	Vdc
Collector-Emitter Cutoff Current (V _{CE} = - 250 Vdc, I _B = 0)	to	ICES		- 50	μAdc
Collector-Base Cutoff Current (V _{CB} = - 280 Vdc, I _E = 0)	1 Am	ICBO	01	-1.0	μAdc
Emitter-Base Cutoff Current (VEB = - 6.0 Vdc, I _C = 0)		IEBO	ZA GERDAN	- 20 11/41 - 2 3311116	μAdc
N CHARACTERISTICS		ricera issue			
DC Current Gain (V _{CE} = - 10 Vdc, I _C = - 50 mAdc)	300	hFE	30	120	-
Collector-Emitter Saturation Voltage (I _C = -50 mAdc, I _B = -5.0 mAdc)	20V	VCE(sat)	7	-2.0	Vdc
YNAMIC CHARACTERISTICS	001				4
Current-Gain — Bandwidth Product (V _{CE} = - 10 Vdc, I _C = - 10 mAdc, f = 30 MHz)		fT	15		MHz
Collector-Base Capacitance (V _{CB} = - 10 Vdc, I _E = 0, f = 1.0 MHz)	08 1	C _{obo}		15	pF

^{*} Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 in².

NPN Silicon Epitaxial Transistors

This family of NPN Silicon Epitaxial transistors is designed for use as a general purpose amplifier and in switching applications. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- High Voltage: V(BR)CFO of 250 and 350 Volts
- The SOT-223 Package can be soldered using wave or reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
 T1 Configuration 7 inch/1000 unit reel.
 T3 Configuration 13 inch/4000 unit reel.
- PNP Complement is the BSP16T1

SOT-223 PACKAGE
NPN SILICON
HIGH VOLTAGE



BSP19AT1

BSP20AT1

CASE 318E-04, STYLE 1 TO-261AA



MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	BSP19A	BSP20A	Unit
Collector-Emitter Voltage (Open Base)	VCEO	350	250	Vdc
Collector-Base Voltage (Open Emitter)	V _{CBO}	400	300	Vdc
Emitter-Base Voltage (Open Collector)	V _{EBO}	5.0		Vdc
Collector Current (DC)	IC	1000		mAdc
Total Power Dissipation @ T _A = 25°C ⁽¹⁾ Derate above 25°C	PD	0.8 6.4		Watts mW/°C
Storage Temperature Range	T _{stg}	-65	to 150	°C
Junction Temperature	TJ	1	50	°C

DEVICE MARKING

SP19A	
SP20A	

THERMAL CHARACTERISTICS

Thermal Resistance from Junction-to-Ambient	R ₀ JA	156	°C/W
Maximum Temperature for Soldering Purposes	TL	260	°C
Time in Solder Bath		10	Sec

^{1.} Device mounted on a FR-4 glass epoxy printed circuit board using minimum recommended footprint.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics		Symbol	Min	Max	Unit
FF CHARACTERISTICS					1000
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	BSP19A BSP20A	V(BR)CEO	350 250	r laix	Vdc
Collector-Base Cutoff Current (V _{CB} = 400 Vdc, I _E = 0) (V _{CB} = 300 Vdc, I _E = 0)	BSP19A BSP20A	ICBO	loon Epitaxi	20 20	nAdc
Emitter-Base Cutoff Current $(V_{BE} = 5.0 \text{ Vdc}, I_C = 0)$	m power surface mount	IEBO	jest <u>a</u> l Nak	10	μAdc
ON CHARACTERISTICS (2)		shoy dec bi	ur car to Oi	SO(RE)V FER	Hov neu
DC Current Gain (I _C = 20 mAdc, V _{CE} = 10 Vdc)	re or refrow. Ig br improved thermal.	hFE	40	ene egestes sackage ene	ESS-TO8
Current Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 5.0 MHz)	inating the possibility of	poloer [†] , elic	70	allo adiz	MHz
Collector-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 4.0 mAdc)	OPTIGO	VCE(sat)	Jeeff Ene ec	0.5	Vdc
Base-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 4.0 mAdc)) 15/48 T	VBE(sat)	13 in cl y400	1.3	Vdc

^{2.} Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

NPN Small-Signal Darlington Transistor

This NPN small signal darlington transistor is designed for use in switching applications, such as print hammer, relay, solenoid and lamp drivers. The device is housed in the SOT-223 package, which is designed for medium power surface mount applications.

- The SOT-223 Package can be soldered using wave or reflow. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
 Use BSP52T1 to order the 7 inch/1000 unit reel.
 Use BSP52T3 to order the 13 inch/4000 unit reel.

PNP Complement is BSP62T1



2 3

CASE 318E-04, STYLE 1 TO-261AA

Motorola Preferred Device

MEDIUM POWER

NPN SILICON

DARLINGTON

TRANSISTOR

SURFACE MOUNT

MAXIMUM RATINGS (Tc = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCES	80	Vdc
Collector-Base Voltage	VCBO	90	Vdc
Emitter-Base Voltage	V _{EBO}	5	Vdc
Collector Current	Ic	500	mAdc
Total Power Dissipation @ T _A = 25°C(1) Derate above 25°C	PD	0.8 6.4	Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{stg}	-65 to 150	°C

DEVICE MARKING

AS3

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)	R ₀ JA	156	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	TL	260 10	°C Sec

^{1.} Device mounted on a FR-4 glass epoxy printed circuit board using minimum recommended footprint.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	La La	man I 53	Marana	5 K.R.62
Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc, I_E = 0$)	V(BR)CBO	90	notos	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	V(BR)EBO	5.0 sat notgoibel	langia ilsmi	Vdc
Collector-Emitter Cutoff Current (VCE = 80 Vdc, VBE = 0)	I OFO	T-223 packa	10	μAdo
Emitter-Base Cutoff Current (VEB = 4.0 Vdc, I _C = 0)	wolfer to see Buy IEBO has	oan be solds	10	μAdo
ON CHARACTERISTICS (2)			et en	ot egeme
DC Current Gain (I _C = 150 mAdc, V _{CE} = 10 Vdc) (I _C = 500 mAdc, V _{CE} = 10 Vdc)	hFE sen tinu 0004 it en tinu 0004/i	1000	n 12 mm Taj 2527 1 10 en 2527 2 10 en	vallable Use 651 Use 831
Collector-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 0.5 mAdc)	VCE(sat)	\$P627#	1.3	Vdc
Base-Emitter On Voltage (I _C = 500 mAdc, I _B = 0.5 mAdc)	V _{BE} (sat)	-	1.9	Vdc

2	Pulse	Test F	Pulse !	Width	< 300	IIS	Duty	Cycle <	2 0%

PNP Small-Signal Darlington Transistor

This PNP small signal darlington transistor is designed for use in switching applications, such as print hammer, relay, solenoid and lamp drivers. The device is housed in the SOT-223 package, which is designed for medium power surface mount applications.

- The SOT-223 Package can be soldered using wave or reflow. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
 Use BSP62T1 to order the 7 inch/1000 unit reel.
 Use BSP62T3 to order the 13 inch/4000 unit reel.
- NPN Complement is BSP52T1



BSP62T1

Motorola Preferred Device

MEDIUM POWER PNP SILICON DARLINGTON TRANSISTOR SURFACE MOUNT



CASE 318E-04, STYLE 1 TO-261AA

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CES}	80	Vdc
Collector-Base Voltage	V _{CBO}	90	Vdc
Emitter-Base Voltage	V _{EBO}	5	Vdc
Collector Current	lc	500	mAdc
Total Power Dissipation @ T _A = 25°C ⁽¹⁾ Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{Stg}	-65 to 150	°C

DEVICE MARKING

BS3

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)	R _θ JA	83.3	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	TL	260 10	°C Sec

^{1.} Device mounted on a FR-4 glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.0625 in.; mounting pad for the collector lead = 0.93 sq. in.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	1	150	11	4715.4
Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc, I_E = 0$)	V _(BR) CBO	90	noton	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	V(BR)EBO	5.0	amail signal	Vdc
Collector-Emitter Cutoff Current (VCE = 80 Vdc, VBE = 0)	I ICPO	CTERRIPES, 10 OT-223 paol Realters	10	μAdc
Emitter-Base Cutoff Current (VEB = 4.0 Vdc, IC = 0)		tos ed neo t	10	μAdc
ON CHARACTERISTICS (2)			elb erif o	demage t
DC Current Gain (I _C = 150 mAdc, V _{CE} = 10 Vdc) (I _C = 500 mAdc, V _{CE} = 10 Vdc)	hFE	1000 2000	17 from S7 no for all #3396 so for 87996	Alta —A 23 asti 38 asti
Collector-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 0.5 mAdc)	VCE(sat)	1 TS 8981	1.3	Vdc
Base-Emitter On Voltage (I _C = 500 mAdc, I _B = 0.5 mAdc)	VBE(sat)	-	1.9	Vdc

^{2.} Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.

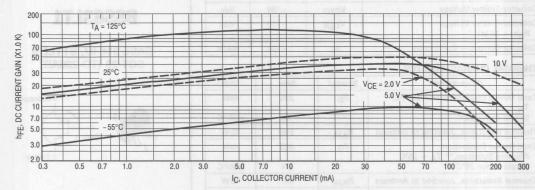


Figure 1. DC Current Gain

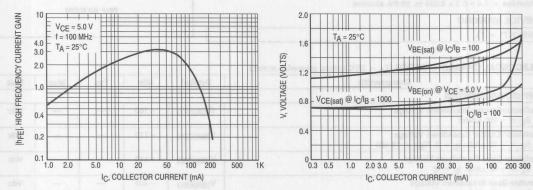


Figure 2. High Frequency Current Gain

Figure 3. "On" Voltage

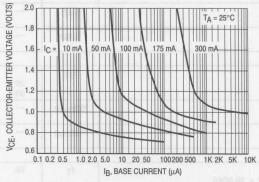


Figure 4. Collector Saturation Region

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-100	Vdc
Collector-Emitter Voltage R _{BE} = 10 kΩ	VCER	-110	Vdc
Collector Current — Continuous	l _C	-100	mAdd

THERMAL CHARACTERISITCS

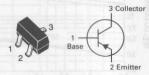
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

DEVICE MARKING

BSS63LT1 = T1

BSS63LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)



HIGH VOLTAGE TRANSISTOR

PNP SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	1-1/- 11/1				- 55
Collector-Emitter Breakdown Voltage (I $_{\rm C} = -100~\mu{\rm Adc}$)	V(BR)CEO	-100			Vdc
Collector-Emitter Breakdown Voltage (I _C = -10μ Adc, I _E = 0 , R _{BE} = $10 k\Omega$)	V(BR)CER	-110		8	Vdc
Collector-Base Breakdown Voltage ($I_E = -10 \mu Adc$, $I_E = 0$)	V(BR)CBO	-110	5.0 10	103 0.7	Vdc
Emitter-Base Breakdown Voltage (I _E = -10 μAdc)	V _{(BR)EBO}	-6.0	uve 2. Hig	- I	Vdc
Collector Cutoff Current $(V_{CB} = -90 \text{ Vdc}, I_{E} = 0)$	СВО	-	1	-100	nAdc
Collector Cutoff Current ($V_{CE} = -110 \text{ Vdc}, R_{BE} = 10 \text{ k}\Omega$)	ICER	NON S	-	-10	μAdc
Emitter Cutoff Current $(V_{EB} = -6.0 \text{ Vdc}, I_{C} = 0)$	IEBO	- 100	-	-200	nAdc
ON CHARACTERISTICS		3			
DC Current Gain (I _C = -10 mAdc, V _{CE} = -1.0 Vdc) (I _C = -25 mAdc, V _{CE} = -1.0 Vdc)	hFE	30 30	=	=	-
Collector-Emitter Saturation Voltage (I _C = -25 mAdc, I _B = -2.5 mAdc)	VCE(sat)	- in- in-	-	-250	mVdc
Base-Emitter Saturation Voltage ($I_C = -25 \text{ mAdc}, I_B = -2.5 \text{ mAdc}$)	V _{BE} (sat)	8-08		-900	mVdc
SMALL-SIGNAL CHARACTERISTICS	0001 3000	180			
Current-Gain Bandwidth Product (IC = -25 mAdc, VCE = -5.0 Vdc, f = 20 MHz)	fT	50	95	-	MHz
Case Capacitance ($I_E = I_C = 0$, $V_{CB} = -10$ Vdc, $f = 1.0$ MHz)	CC	-		5.0	pF

^{*}FR-5 = 1.0 x 0.75 x 0.062 in. **Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

MAXIMOM NATINGS			
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	80	Vdc
Collector-Base Voltage	VCBO	120	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	IC.	100	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{sta}	-55 to +150	°C

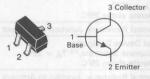
^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BSS64LT1 = AM

BSS64LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)



DRIVER TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS			BOTH METOA	17 HO \$10
Collector-Emitter Breakdown Voltage Collector-Emitter Breakdown Voltage Collector (IC = 4.0 mA)	V(BR)CEO	80	bite in L <u>w</u> ittier (obAm-l	Vdc
Collector-Base Breakdown Voltage (I _C = 100 µA)	V(BR)CBO	120	Sutoff Current 10 Vita Ig et	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 µA)	V _{(BR)EBO}	5.0	ACTERISTICS	Vdc
Collector Cutoff Current (V _{CE} = 90 V) (T _A = 150°C)	ICBO	(sbV_0.1 = 1.01/dc)	0.1 500	μΑ
Emitter Cutoff Current (VEB = 4.0V)	I _{EBO}	patieV righ	200	nA
ON CHARACTERISTICS		Jab Ave A 3	an all also an	1 = 00
DC Current Gain (V _{CE} = 1.0 V, I _C = 10 mA)	hFE	20	e gi st Am.	id in di ma _{nun} i
Collector-Emitter Saturation Voltage (I _C = 4.0 mA, I _B = 400 μ A) (I _C = 50 mA, I _B = 15 mA)	VCE(sat)	(otsAm 0.) (ots/— 0.8	0.15 0.2	Vdc
Forward Base-Emitter Voltage	V _{BE} (sat)	malarests at the	Sept Total	Outropy and
SMALL-SIGNAL CHARACTERISTICS	(sRM cot =	t sal-V or -	nevds, Veg	00 = 10
Current-Gain — Bandwidth Product ($I_C = 4.0 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $f = 20 \text{ MHz}$)	f _T	60	padit u ca 5.0 Vdo,Jg -	MHz
Output Capacitance (V _{CB} = 10 V, f = 1.0 MHz)	C _{ob}	0,1 = 1,0	5.0	pF

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	12	Vdc
Collector-Base Voltage	V _{CBO}	20	Vdc
Collector Current — Continuous	lc	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_{\hbox{$\mbox{Λ}}} = 25^{\circ}\hbox{$\mbox{$\mbox{C}$}}$ Derate above 25°C	PD	225	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** TA = 25°C Derate above 25°C	PD	300	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tsta	-55 to +150	°C

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BSV52LT1 = B2

BSV52LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





SWITCHING TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS			овтанатом	IAHO TTO
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc)	V(BR)CEO	12	Emitt e- Draut D mAj	Vdc
Collector Cutoff Current (V _{CB} = 10 Vdc, I _E = 0) (V _{CB} = 10 Vdc, I _E = 0, T _A = 125°C)	ІСВО	eganloV nwo	100 5.0	nAdc μAdc
ON CHARACTERISTICS			(Au Di	0 = 10
DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc)	hFE	25 40 25	120	Continuit
Collector-Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}$, $I_B = 300 \mu \text{Adc}$) ($I_C = 10 \text{ mAdc}$, $I_B = 1.0 \text{ mAdc}$) ($I_C = 50 \text{ mAdc}$, $I_B = 5.0 \text{ mAdc}$)	V _{CE(sat)}	=	300 250 400	mVdc
Base-Emitter Saturation Voltage (IC = 10 mAdc, I _B = 1.0 mAdc) (IC = 50 mAdc, I _B = 5.0 mAdc)	V _{BE} (sat)	700	850 1200	mVdc
SMALL-SIGNAL CHARACTERISTICS		UAm a	F 8 9 5 10 (S 44 28
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	fT	400	ONAL CHAR	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	vidth Ps oduct = 10 V. f = 20	4.0	pF
Input Capacitance (VEB = 1.0 Vdc, I _C = 0, f = 1.0 MHz)	C _{ibo}	Calification (4.5	pF
SWITCHING CHARACTERISTICS				
Storage Time $(I_C = I_{B1} = I_{B2} = 10 \text{ mAdc})$	t _S	-	13	ns
Turn-On Time (VBE = 1.5 Vdc, I_C = 10 mAdc, I_B = 3.0 mAdc)	t _{on}	-	12	ns
Turn-Off Time (I _C = 10 mAdc, I _B = 3.0 mAdc)	toff	-	18	ns

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-35	Vdc
Collector-Base Voltage	V _{CBO}	-40	Vdc
Emitter-Base Voltage	V _{EBO}	- 25	Vdc
Collector Current — Continuous	Ic	- 150	mAdc

THERMAL CHARACTERISITCS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT404ALT1 = 2N

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = -10 mAdc, I _B = 0)	V(BR)CEO	-35	_	-	Vdc
Collector-Emitter Breakdown Voltage (I _C = -10μ Adc, I _E = 0)	V(BR)CBO	-40	-	-	Vdc
Emitter-Base Breakdown Voltage (I _E = -10μ Adc, I _C = 0)	V(BR)EBO	- 25	-	-	Vdc
Collector Cutoff Current ($V_{CB} = -10 \text{ Vdc}, I_E = 0$)	ІСВО	-	-	-100	nAdc
Emitter Cutoff Current ($V_{EB} = -10 \text{ Vdc}, I_{C} = 0$)	IEBO	= =	-	-100	nAdc
ON CHARACTERISTICS			74-4-1		
DC Current Gain ($I_C = -12 \text{ mAdc}, V_{CE} = -0.15 \text{ Vdc}$)	hFE	100	-	400	_
Collector-Emitter Saturation Voltage ($I_C = -12$ mAdc, $I_B = -0.4$ mAdc) ($I_C = -24$ mAdc, $I_B = -1.0$ mAdc)	VCE(sat)	=	=	-0.15 -0.20	Vdc
Base-Emitter Saturation Voltage ($I_C = -12 \text{ mAdc}$, $I_B = -0.4 \text{ mAdc}$) ($I_C = -24 \text{ mAdc}$, $I_B = -1.0 \text{ mAdc}$)	V _{BE} (sat)	=	_	-0.85 -1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS		result in			
Output Capacitance (V _{CB} = -6.0 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	-	-	20	pF
SWITCHING CHARACTERISTICS					
Delay Time ($V_{CC} = -10 \text{ Vdc}$, $I_{C} = -10 \text{ mAdc}$) (Figure 1)	^t d	-	43		ns
Rise Time $(I_{B1} = -1.0 \text{ mAdc}, V_{BE(off)} = -14 \text{ Vdc})$	t _r	-	180		ns
Storage Time $(V_{CC} = -10 \text{ Vdc}, I_{C} = -10 \text{ mAdc})$	t _S	-	675	-	ns
Fall Time ($I_{B1} = I_{B2} = -1.0 \text{ mAdc}$) (Figure 1)	tf	-	160	-	ns

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





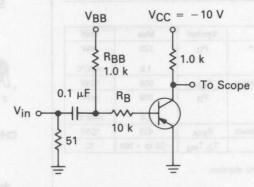
CHOPPER TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

FIGURE 1 — SWITCHING TIME TEST CIRCUIT



	V _{in} (Volts)	V _{BB} (Volts)
ton, td, tr	- 12	+1.4
toff, ts and tf	+20.6	-11.6

Voltages and resistor values shown are for $I_C = 10$ mA, $I_C/I_B = 10$ and $I_{B1} = I_{B2}$

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	15	Vdc
Collector-Base Voltage	VCBO	30	Vdc
Emitter-Base Voltage	V _{EBO}	3.0	Vdc
Collector Current — Continuous	IC IC	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_{\mbox{\scriptsize A}} = 25^{\circ} \mbox{\scriptsize C}$	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT918LT1 = M3B

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	Am 0.1 = al				
Collector-Emitter Breakdown Voltage (I _C = 3.0 mAdc, I _B = 0)	V _{CE} = 6.0 Volta Rq = 60 Ω	V(BR)CEO	15	-	Vdc
Collector-Base Breakdown Voltage (I _C = 1.0 μAdc, I _E = 0)	f = 60 MHz	V(BR)CBO	30	-	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0)	Gpe Test Condition	V(BR)EBO	3.0	-	Vdc
Collector Cutoff Current (V _{CB} = 15 Vdc, I _E = 0)	V _{CE} = 12 Volts f = 200 MHz	ІСВО	-	50	nAdc
ON CHARACTERISTICS			16 10 11 11		hervin lei
DC Current Gain ($I_C = 3.0 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$)		hFE	20	-	_
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)		V _{CE} (sat)	= 1	0.4	Vdc
Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)		V _{BE(sat)}	-	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					A PARA
Current-Gain — Bandwidth Product (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)		fT	600	-	MHz
Output Capacitance (V _{CB} = 0 Vdc, I _E = 0, f = 1.0 MHz) (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}	=	3.0 1.7	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0 , f = 1.0 MHz)		C _{ibo}	_	2.0	pF
Noise Figure (I _C = 1.0 mAdc, V_{CE} = 6.0 Vdc, R_S = 50 Ω , f = 60 MHz) (Figure 1)		NF	-	6.0	dB
Power Output (I _C = 8.0 mAdc, V _{CB} = 15 Vdc, f = 500 MHz)		Pout	30	-	mW
Common-Emitter Amplifier Power Gain (IC = 6.0 mAdc, VCR = 12 Vdc, f = 200 MHz)		Gpe	11	-	dB

MMBT918LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)



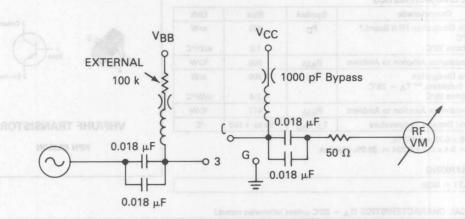


VHF/UHF TRANSISTOR

NPN SILICON

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

FIGURE 1 — NF, Gpe MEASUREMENT CIRCUIT 20-200



NF Test Conditions $I_C=1.0$ mA $V_{CE}=6.0$ Volts $R_S=50~\Omega$ f=60 MHz

 $\begin{array}{l} \text{G}_{\text{pe}} \text{ Test Conditions} \\ \text{I}_{\text{C}} = 6.0 \text{ mA} \\ \text{V}_{\text{CE}} = 12 \text{ Volts} \\ \text{f} = 200 \text{ MHz} \end{array}$

Rating	Symbol	MMBT2222	MMBT2222A	Unit
Collector-Emitter Voltage	VCEO	30	40	Vdc
Collector-Base Voltage	VCBO	60	75	Vdc
Emitter-Base Voltage	VEBO	5.0	6.0	Vdc
Collector Current — Continuous	Ic	600		mAdd

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C	T	1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT2222LT1 = M1B; MMBT2222ALT1 = 1P

MMBT2222LT1 MMBT2222ALT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)



Symbol Min



GENERAL PURPOSE TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

Refer to MPS2222 for graphs.

Max

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic

Onto	lacteristic		Cyllibol	IAIIII	IVIGA	Omit
OFF CHARACTERISTICS		THE STATE OF THE S	137 94 10.1		28627	weetle A. Australia
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	907	MMBT2222 MMBT2222A	V(BR)CEO	30 40	Ade, Vog =	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0)	- NA	MMBT2222 MMBT2222A	V(BR)CBO	60 75	Add Vcs -	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)	1,2	MMBT2222 MMBT2222A	V _{(BR)EBO}	5.0 6.0	CHAINCLE	Vdc
Collector Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc)	4	MMBT2222A	ICEX	10 = 169 r	10	nAdc
Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0) (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 50 Vdc, I _E = 0, T _A = 125°C) (V _{CB} = 50 Vdc, I _E = 0, T _A = 125°C)	v	MMBT2222 MMBT2222A MMBT2222 MMBT2222A	ICBO	ggi = rgi G ,es <u>, not =</u> de le yene	0.01 0.01 10 10	μAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0)		MMBT2222A	IEBO	-	100	nAdc
Base Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc)		MMBT2222A	IBL	=	20	nAdc
ON CHARACTERISTICS						
DC Current Gain $ \begin{aligned} &(I_{\text{C}} = 0.1 \text{ mAdc, V}_{\text{CE}} = 10 \text{ Vdc}) \\ &(I_{\text{C}} = 1.0 \text{ mAdc, V}_{\text{CE}} = 10 \text{ Vdc}) \\ &(I_{\text{C}} = 10 \text{ mAdc, V}_{\text{CE}} = 10 \text{ Vdc}) \\ &(I_{\text{C}} = 10 \text{ mAdc, V}_{\text{CE}} = 10 \text{ Vdc}) \\ &(I_{\text{C}} = 150 \text{ mAdc, V}_{\text{CE}} = 10 \text{ Vdc}) (1) \\ &(I_{\text{C}} = 150 \text{ mAdc, V}_{\text{CE}} = 1.0 \text{ Vdc}) (1) \\ &(I_{\text{C}} = 500 \text{ mAdc, V}_{\text{CE}} = 10 \text{ Vdc}) (1) \end{aligned} $	– 55°C)	MMBT2222A only MMBT2222 MMBT2222A	hFE	35 50 75 35 100 50 30 40	300	-
Collector-Emitter Saturation Voltage(1) $(I_C = 150 \text{ mAdc}, I_B = 15 \text{ mAdc})$		MMBT2222 MMBT2222A	V _{CE(sat)}	=	0.4 0.3	Vdc
$(I_C = 500 \text{ mAdc}, I_B = 50 \text{ mAdc})$		MMBT2222 MMBT2222A		Ξ	1.6 1.0	

Note: "LT1" must be used when ordering SOT-23 devices.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Characteristic	75 Vdc	Symbol	Min	Max	Unit
Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc)	MMBT2222 MMBT2222A	V _{BE} (sat)	0.6	1.3 1.2	Vdc
$(I_C = 500 \text{ mAdc}, I_B = 50 \text{ mAdc})$	MMBT2222 MMBT2222A	Symbo	IISTICS lc	2.6 2.0	J JANUARA
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	MMBT2222 MMBT2222A	fT ALINE IN	250 300	ve 25°C stanc <u>e June</u>	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	Wm 998	C _{obo}	V = 52/C	8.0	pF
Input Capacitance $(V_{EB} = 0.5 \text{ Vdc}, I_{C} = 0, f = 1.0 \text{ MHz})$	MMBT2222 MMBT2222A	Cibo	on to Aurible	30 25	Aq PF
Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A MMBT2222A	h _{ie}	2.0 0.25	8.0 1.25	kΩ
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A MMBT2222A	h _{re}	JASSEETEM	8.0 4.0	X 10-4
Small-Signal Current Gain (IC = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (IC = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A MMBT2222A	h _{fe}	50 75	300 375	LOIRTON.
Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A MMBT2222A	h _{oe}	5.0 25	35 200	μmhos
Collector Base Time Constant (I _E = 20 mAdc, V _{CB} = 20 Vdc, f = 31.8 MHz)	MMBT2222A	rb'C _C	Voltage	150	ps B-10700II
Noise Figure (I _C = 100 μ Adc, V _{CE} = 10 Vdc, R _S = 1.0 k Ω , f =	1.0 kHz) MMBT2222A	NF	-	4.0	dB
SWITCHING CHARACTERISTICS MMBT2222A only	2227B00A		THE PARTY OF THE P	the le = 01	on 01 = of
Delay Time (V _{CC} = 30 Vdc, V _{BE(off)}		td	_	10	ns
Rise Time I _C = 150 mAdc, I _{B1} = 1	mAdc)	t _r	_	25	ns
Storage Time $(V_{CC} = 30 \text{ Vdc}, I_{C} = 150 \text{ IB1} = I_{B2} = 15 \text{ mAdc})$	mAdc,	t _S	SERV V.E =	225 60	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	ferr se15 antro a	Vdc
Collector-Emitter Voltage	VCES	40	Vdc
Collector-Base Voltage	VCBO	40	Vdc
Emitter-Base Voltage	VEBO	4.5	Vdc
Collector Current — Continuous	Ic	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{stg}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT2369LT1 = M1J MMBT2369ALT1 = 1JA

MMBT2369LT1 MMBT2369ALT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





SWITCHING TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

Refer to 2N2369 in Section 3 for graphs.

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (1) (I _C = 10 mAdc, I _B = 0)		V _(BR) CEO	15	-	= =	Vdc
Collector-Emitter Breakdown Voltage (I _C = 10 μ Adc, V _{BE} = 0)		V _(BR) CES	40	_	-	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _E = 0)		V(BR)CBO	40	-	+	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)		V _{(BR)EBO}	4.5	-	-	Vdc
Collector Cutoff Current $(V_{CB} = 20 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = 20 \text{ Vdc}, I_{E} = 0, T_{A} = 150^{\circ}\text{C})$		СВО	=	=	0.4 30	μAdc
Collector Cutoff Current (V _{CE} = 20 Vdc, V _{BE} = 0)	MMBT2369A	ICES	-	-	0.4	μAdd
ON CHARACTERISTICS						
DC Current Gain(1) $ \begin{aligned} &(I_C = 10 \text{ mAdc, } V_{CE} = 1.0 \text{ Vdc)} \\ &(I_C = 10 \text{ mAdc, } V_{CE} = 1.0 \text{ Vdc)} \\ &(I_C = 10 \text{ mAdc, } V_{CE} = 0.35 \text{ Vdc)} \\ &(I_C = 10 \text{ mAdc, } V_{CE} = 0.35 \text{ Vdc, } T_{A} = -55^{\circ}\text{C}) \\ &(I_C = 30 \text{ mAdc, } V_{CE} = 0.4 \text{ Vdc)} \\ &(I_C = 100 \text{ mAdc, } V_{CE} = 2.0 \text{ Vdc)} \\ &(I_C = 100 \text{ mAdc, } V_{CE} = 1.0 \text{ Vdc)} \end{aligned} $	MMBT2369 MMBT2369A MMBT2369A MMBT2369A MMBT2369A MMBT2369 MMBT2369A	h _{FE}	40 		120 120 — — — —	
Collector-Emitter Saturation Voltage(1) $ \begin{aligned} &(I_C=10 \text{ mAdc, } I_B=1.0 \text{ mAdc}) \\ &(I_C=10 \text{ mAdc, } I_B=1.0 \text{ mAdc}) \\ &(I_C=10 \text{ mAdc, } I_B=1.0 \text{ mAdc}, \\ &(I_C=30 \text{ mAdc, } I_B=3.0 \text{ mAdc}) \\ &(I_C=30 \text{ mAdc, } I_B=3.0 \text{ mAdc}) \\ &(I_C=100 \text{ mAdc, } I_B=10 \text{ mAdc}) \end{aligned} $	MMBT2369 MMBT2369A MMBT2369A MMBT2369A MMBT2369A	VCE(sat)	=	= = = = = = = = = = = = = = = = = = = =	0.25 0.20 0.30 0.25 0.50	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 10 \text{ mAdc}$, $I_B = 1.0 \text{ mAdc}$) ($I_C = 10 \text{ mAdc}$, $I_B = 1.0 \text{ mAdc}$, $I_A = -55^{\circ}\text{C}$) ($I_C = 30 \text{ mAdc}$, $I_B = 3.0 \text{ mAdc}$) ($I_C = 100 \text{ mAdc}$, $I_B = 10 \text{ mAdc}$)	MMBT2369,A MMBT2369A MMBT2369A MMBT2369A	VBE(sat)	0.7 	=	0.85 1.02 1.15 1.60	Vdc

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

MMBT2369LT1 MMBT2369ALT1

ELECTRICAL CHARACT	ERISTICS (continued) (7	$\Gamma_{\Delta} = 25^{\circ}$	°C unless otherwise noted.)
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Characteristic		Symbol	Min	Тур	Max	Unit
SMALL-SIGNAL CHARACTERISTICS	ADV VOIC	94 0	say .		agotloV at	nd-notice
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	obV	C _{obo}	N -	auctin	4.0	pF
Small Signal Current Gain (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)		h _{fe}	5.0	POLYSIA	- magagawa	120/05
SWITCHING CHARACTERISTICS	losts I	webs tool	ensol	e de	electron con C.	
Storage Time $(I_{B1} = I_{B2} = I_C = 10 \text{ mAdc})$	Wm	t _S	10 -	5.0	13	ns
Turn-On Time $(V_{CC} = 3.0 \text{ Vdc}, I_{C} = 10 \text{ mAdc}, I_{B1} = 3.0 \text{ mAdc})$	OnWen User	ton	uff to	8.0	12	ns
Turn-Off Time ($V_{CC} = 3.0 \text{ Vdc}$, $I_{C} = 10 \text{ mAdc}$, $I_{B1} = 3.0 \text{ mAdc}$, I_{B2}	= 1.5 mAdc)	toff	7	10	18	ns

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	60	Vdc
Collector-Base Voltage	VCBO	60	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	Ic	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T _A = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT2484LT1 = 1U

MMBT2484LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





LOW NOISE TRANSISTOR

NPN SILICON

Refer to MPSA18 for graphs.

Cha	aracteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	OSO(BE)V		1	un. Vottagef	philosoft next of	iB oftenll
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)		ATDESTRAM	V(BR)CEO	60	St. Salarini	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu Adc, I_E = 0$)	OBSTRBIA		V(BR)CBO	60	- gl JbAg (Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)	OEBORIN.		V(BR)EBO	5.0	= gl, jbAu, (Vdc
Collector Cutoff Current	Xaol		ІСВО	0.0 m-	30 Vide Vice	55/6
(V _{CB} = 45 Vdc, I _E = 0) (V _{CB} = 45 Vdc, I _E = 0, T _A 150°C)	lese			=	10 10	nAdc μAdc
Emitter Cutoff Current (VEB = 5.0 Vdc, I _C = 0)			IEBO	- "	10	nAdc
ON CHARACTERISTICS		MMETERON	(08	ST - AT A	w glaby oa	- 80%
DC Current Gain		ArpesTalum	hFE			
$(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$ $(I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$			Sale Sale	250 —	800	WE COME
Collector-Emitter Saturation Voltage $(I_C = 1.0 \text{ mAdc}, I_B = 0.1 \text{ mAdc})$			VCE(sat)	_	0.35	Vdc
Base-Emitter On Voltage (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc)		MARETZBOZA MARETZBOZA	V _{BE(on)}	nbV 04	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS		- Characterist		as University	San State of	
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1 MHz)		AVBESTEMAL	C _{obo}	-	6.0	pF
Input Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz	2)	MMBT2902 MMBT2902A	Cibo	aby el	6.0	pF
Noise Figure (IC = 10 µAdc, VCF = 5.0 Vdc, RS =	= 10 kΩ, f = 1.	0 kHz, BW = 200 Hz)	NF	ω =10.Vd	3.0	dB

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	MMBT2907	MMBT29074	Unit
Collector-Emitter Voltage	VCEO	-40	-60	Vdc
Collector-Base Voltage	VCBO	-60		Vdc
Emitter-Base Voltage	VEBO	-5.0		Vdc
Collector Current — Continuous	Ic	-600		mAdd

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T _A = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT2907LT1 = M2B MMBT2907ALT1 = 2F

MMBT2907LT1 MMBT2907ALT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTORS

PNP SILICON

★This is a Motorola designated preferred device.

Refer to MPS2907 for graphs.

C	naracteristic	Loston ealerorito appl	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	lo dany8		allamateur p	dO		
Collector-Emitter Breakdown Voltage $(I_C = -10 \text{ mAdc}, I_B = 0)$	(1) 083(88) ^V	MMBT2907 MMBT2907A	V(BR)CEO	-40 -60	Cremerios inor Breakth	Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc, I_E = 0$)	Уширово -		V _(BR) CBO	-60	ne Brakdown	Vdc
Emitter-Base Breakdown Voltage (I _E = -10μ Adc, I _C = 0)	оваяву		V(BR)EBO	-5.0	Braghtown A	Vdc
Collector Cutoff Current (VCE = -30 Vdc, VEB(off) = -0.5	Vdc)		ICEX	-	-50	nAdc
Collector Cutoff Current (V _{CB} = -50 Vdc, I _E = 0)	083	MMBT2907 MMBT2907A	ІСВО	TA 160'53	-0.020 -0.010	μAdc
$(V_{CB} = -50 \text{ Vdc}, I_{E} = 0, T_{A} = 12)$	5°C)	MMBT2907 MMBT2907A		=	-20 -10	A GRARD &
Base Current (VCE = -30 Vdc, VEB(off) = -0.5	i Vdc		IB	5.0 Vdq -	-50	nAdc
ON CHARACTERISTICS	(tea) 90V			apattoV n	iltər Seturatio	llectoring
DC Current Gain $(I_C = -0.1 \text{ mAdc}, V_{CE} = -10 \text{ Vd})$	(maj 34) ^V	MMBT2907 MMBT2907A	hFE	35		0.0 = 0.0
$(I_C = -1.0 \text{ mAdc}, V_{CE} = -10 \text{ Vd})$	c) odo ²	MMBT2907 MMBT2907A		75 50 100	- Barriera	AAUL-616 Iput Cept Vg8 ~ h
$(I_C = -10 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})$	6000	MMBT2907 MMBT2907A		MA 0 75	sonat S vo. — S = 1	out Capan Vee = 0
$(I_C = -150 \text{ mAdc}, V_{CE} = -10 \text{ Vc})$	c)(1)	MMBT2907 MMBT2907A	= 1.0a or =	100	300	ice Figuri IC = 10
(I _C = -500 mAdc, V _{CE} = -10 Vc	lc)(1)	MMBT2907 MMBT2907A		30 50	_	
Collector-Emitter Saturation Voltage ($I_C = -150 \text{ mAdc}$, $I_B = -15 \text{ mAdc}$ ($I_C = -500 \text{ mAdc}$, $I_B = -50 \text{ mAdc}$	lc)		VCE(sat)	Ξ	-0.4 -1.6	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = -150 \text{ mAdc}$, $I_B = -15 \text{ mAd}$ ($I_C = -500 \text{ mAdc}$, $I_B = -50 \text{ mAdd}$			V _{BE(sat)}	=	-1.3 -2.6	Vdc

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

6.2.00	Characteristic	obV	- 12	Symbol	Min	Max	Unit
SMALL-SIGNAL CH	ARACTERISTICS	algV	0.8 -	_oasv		a gatlo V	nes8 retile
	ndwidth Product(1),(2) VCE = -20 Vdc, f = 100 MHz)	stiAnn	(8-	of f _T	200	rem — Contin	MHz
Output Capacitance (V _{CB} = -10 Vdc,	le = 0, f = 1.0 MHz)	dell		C _{obo}	St. G e	8.0	pF
Input Capacitance (V _{EB} = -2.0 Vdc	c, I _C = 0, f = 1.0 MHz)	Wen	226	Cibo	*.bacoll &-l	30	pF
SWITCHING CHARA	ACTERISTICS	3°Wm	8.1				ode exerció
Turn-On Time		WO	856	ton	idmA -o r no	45	ns
Delay Time	$(V_{CC} = -30 \text{ Vdc}, I_{C} = -150 \text{ m})$ $I_{B1} = -15 \text{ mAdc})$	Adc,		t _d	-	10	ns
Rise Time	IBI - 19 III/dc/	Autoli		t _r	3/82 =	40	ns
Turn-On Time	$(V_{CC} = -6.0 \text{ Vdc}, I_{C} = -150 \text{ mAdc}, I_{B1} = I_{B2} = -15 \text{ mAdc})$	48000	716	toff		100	ns
Delay Time		nAdc,		t _S	Contract of the contract of th	80	ns
Rise Time				tf	93970304	30	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	- 12	Vdc
Collector-Base Voltage	V _{CBO}	-12	Vdc
Emitter-Base Voltage	V _{EBO}	-4.0	Vdc
Collector Current — Continuous	Ic	-80	mAdd

THERMAL CHARACTERISITCS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** TA = 25°C Derate above 25°C	P PD	300	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	TJ, Tstq	-55 to +150	°C

DEVICE MARKING

MMBT3640LT1 = 2J

MMBT3640LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





SWITCHING TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

Refer to MPS3640 for graphs.

Mar III	Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERIST	rics				
Collector-Emitter Bre	eakdown Voltage ($I_C = -100 \mu Adc, V_{BE} = 0$)	V(BR)CES	-12	-	Vdc
Collector-Emitter Su	staining Voltage(1) ($I_C = -10$ mAdc, $I_B = 0$)	V _{CEO(sus)}	-12		Vdc
Collector-Base Break	xdown Voltage ($I_C = -100 \mu Adc, I_E = 0$)	V(BR)CBO	-12		Vdc
Emitter-Base Breakd	own Voltage ($I_E = -100 \mu Adc$, $I_C = 0$)	V(BR)EBO	-4.0	_	Vdc
Collector Cutoff Cur	rent ($V_{CE} = -6.0 \text{ Vdc}$, $V_{BE} = 0$) ($V_{CE} = -6.0 \text{ Vdc}$, $V_{BE} = 0$, $T_{A} = 65^{\circ}\text{C}$)	ICES	_	-0.01 -1.0	μAdc
Base Current ($V_{CE} = -6.0 \text{ Vdc}$, $V_{EB} = 0$)		IB	_	- 10	nAdc
ON CHARACTERIST	ICS(1)				
	$C = -10 \text{ mAdc}, V_{CE} = -0.3 \text{ Vdc})$ $C = -50 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc}$	hFE	30 20	120 —	_
Collector-Emitter Saturation Voltage ($I_C = -10 \text{ mAdc}$, $I_B = -1.0 \text{ mAdc}$) ($I_C = -50 \text{ mAdc}$, $I_B = -5.0 \text{ mAdc}$) ($I_C = -10 \text{ mAdc}$, $I_B = -1.0 \text{ mAdc}$, $I_A = 65^{\circ}\text{C}$)		VCE(sat)	Ξ	-0.2 -0.6 -0.25	Vdc
Base-Emitter Saturation Voltage ($I_C = -10 \text{ mAdc}$, $I_B = -0.5 \text{ mAdc}$) ($I_C = -10 \text{ mAdc}$, $I_B = -1.0 \text{ mAdc}$) ($I_C = -50 \text{ mAdc}$, $I_B = -5.0 \text{ mAdc}$)		VBE(sat)	-0.75 -0.8	-0.95 -1.0 -1.5	Vdc
SMALL-SIGNAL CHA	ARACTERISTICS				
Current-Gain — Ban (I _C = -10 mAdc,	dwidth Product V _{CE} = -5.0 Vdc, f = 100 MHz)	fT	500	_	MHz
Output Capacitance	$(V_{CB} = -5.0 \text{ Vdc}, I_{E} = 0, f = 1.0 \text{ MHz})$	Cobo		3.5	pF
Input Capacitance	$(V_{EB} = -0.5 \text{ Vdc}, I_{C} = 0, f = 1.0 \text{ MHz})$	Cibo		3.5	pF
SWITCHING CHARA	CTERISTICS				
Delay Time	$(V_{CC} = -6.0 \text{ Vdc}, I_{C} = -50 \text{ mAdc}, V_{EB(off)} = -1.9 \text{ Vdc},$	td	_	10	ns
Rise Time	$I_{B1} = -5.0 \text{ mAdc}$	tr		30	ns
Storage Time	$(V_{CC} = -6.0 \text{ Vdc}, I_{C} = -50 \text{ mAdc}, I_{B1} = I_{B2} = -5.0 \text{ mAdc})$	t _S	_	20	ns
Fall Time		tf	_	12	ns
	, I _C = -50 mAdc, V _{EB(off)} = -1.9 Vdc, I _{B1} = -5.0 mAdc) , I _C = -10 mAdc, I _{B1} = -0.5 mAdc)	ton	_	25 60	ns
	, I _C = -50 mAdc, V _{EB(off)} = -1.9 V, I _{B1} = I _{B2} = -5.0 mAdc) , I _C = -10 mAdc, I _{B1} = I _{B2} = -0.5 mAdc)	toff	-	35 75	ns

^{*}FR-5 = 1.0 x 0.75 x 0.062 in. **Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	VCBO	60	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	Ic	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C	4	1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	T _J , T _{stq}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT3904LT1 = 1AM

MMBT3904LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Refer to 2N3903 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS			14111	
Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0)	V(BR)CEO	40	-	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _E = 0)	V(BR)CB0	60		Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V _{(BR)EBO}	6.0	-	Vdc
Base Cutoff Current (V _{CE} = 30 Vdc, V _{EB} = 3.0 Vdc)	I _{BL}		50	nAdc
Collector Cutoff Current (V _{CE} = 30 Vdc, V _{EB} = 3.0 Vdc)	ICEX		50	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain(1) (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc)	hFE	40 70 100 60 30	300	
Collector-Emitter Saturation Voltage(1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc)	V _{CE(sat)}	= 1	0.2 0.3	Vdc
Base-Emitter Saturation Voltage(1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc)	V _{BE(sat)}	0.65	0.85 0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	fT	300	_	MHz
Output Capacitance ($V_{CB} = 5.0 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C _{obo}	_	4.0	pF
Input Capacitance $(V_{EB} = 0.5 \text{ Vdc}, I_{C} = 0, f = 1.0 \text{ MHz})$	C _{ibo}		8.0	pF
Input Impedance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz)	h _{ie}	1.0	10	k ohms
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	h _{re}	0.5	8.0	X 10-4

(I_C = $\overline{1.0}$ mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (1) Pulse Test: Pulse Width $\leq 300 \ \mu s$, Duty Cycle $\leq 2.0\%$.

Rev 1

Small-Signal Current Gain

100

hfe

400

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°c unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	h _{oe}	1.0	40	μ mhos
Noise Figure (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 1.0 k ohms, f = 1.0 kHz)	NF	201730	5.0	dB

SWITCHING CHARACTERISTICS

Delay Time	$(V_{CC} = 3.0 \text{ Vdc}, V_{BE} = -0.5 \text{ Vdc},$	t _d	S, Smitou 8-19	35	ns
Rise Time	I _C = 10 mAdc, I _{B1} = 1.0 mAdc)	t _r	_	35	ns
Storage Time	$(V_{CC} = 3.0 \text{ Vdc}, I_{C} = 10 \text{ mAdc}, I_{B1} = I_{B2} = 1.0 \text{ mAdc})$	t _S	_	200	ns
Fall Time		tf	IN ARRA OF HOL	50	nerntal mon

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-40	Vdc
Collector-Base Voltage	V _{CBO}	-40	Vdc
Emitter-Base Voltage	V _{EBO}	-5.0	Vdc
Collector Current — Continuous	lc	-200	mAdo

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C	-4	1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	P _D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

DEVICE MARKING

MMBT3906LT1 = 2A

MMBT3906LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

Refer to 2N3905 for graphs.

ELECTRICAL CHARACTERISTICS (T _A = 25°C unless otherwise not	ed.)			
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	(SEADI VI.)	28 - 10		amiT He
Collector-Emitter Breakdown Voltage (1) (IC = -1.0 mAdc, I _B = 0)	V(BR)CEO	-40	au 0 <u>00</u> ≥ 10	Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc$, $I_E = 0$)	V(BR)CBO	-40	-	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc$, $I_C = 0$)	V(BR)EBO	-5.0	-	Vdc
Base Cutoff Current $(V_{CE} = -30 \text{ Vdc}, V_{EB} = -3.0 \text{ Vdc})$	IBL	-	-50	nAdc
Collector Cutoff Current (V _{CE} = -30 Vdc, V _{EB} = -3.0 Vdc	ICEX	-	-50	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain $(I_C = -0.1 \text{ mAdc, } V_{CE} = -1.0 \text{ Vdc})$ $(I_C = -1.0 \text{ mAdc, } V_{CE} = -1.0 \text{ Vdc})$	h _{FE}	60	_	=

DC Current Gain	hFE			_
$(I_C = -0.1 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})$		60	_	
$(I_C = -1.0 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})$		80	_	
$(I_C = -10 \text{ mAdc}, V_{CF} = -1.0 \text{ Vdc})$		100	300	
$(I_C = -50 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})$		60	_	
$(I_C = -100 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})$		30	-	
Collector-Emitter Saturation Voltage	VCE(sat)			Vdc
$(I_C = -10 \text{ mAdc}, I_B = -1.0 \text{ mAdc})$		_	-0.25	
$(I_C = -50 \text{ mAdc}, I_B = -5.0 \text{ mAdc})$		_	-0.4	
Base-Emitter Saturation Voltage	VBE(sat)			Vdc
$(I_C = -10 \text{ mAdc}, I_B = -1.0 \text{ mAdc})$	22(00)	-0.65	-0.85	
$(I_C = -50 \text{ mAdc}, I_B = -5.0 \text{ mAdc})$		_	-0.95	

^{*}FR-5 = 1.0 x 0.75 x 0.062 in. **Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted).

Characteristic			Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS	obV	- 5.0	oasy		ygahoV e	rwitter-Base
Current-Gain — Bandwidth Product (I _C = -10 mAdc, V _{CE} = -20 Vdc, f = 100 MHz)	mAde	200	of f	250	103 - 105Y	MHz
Output Capacitance (V _{CB} = -5.0 Vdc, I _E = 0, f = 1.0 MHz)	rinu .	totM	C _{obo}	Sun I sure pite	4.5	pF
Input Capacitance (VEB = -0.5 Vdc, I _C = 0, f = 1.0 MHz)	Wm	226	Cibo	ineoù è-Ri	10.0	pF
Input Impedance (I _C = -1.0 mAdc, V _{CE} = -10 Vdc, f = 1.0 kHz)	O WANT	838	h _{ie}	2.0	12	k ohms
Voltage Feedback Ratio $(I_C = -1.0 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}, f = 1.0 \text{ kHz})$	Wm	300	h _{re}	0.1 3°88 = A7	10	X 10-4
Small-Signal Current Gain (I _C = -1.0 mAdc, V _{CE} = -10 Vdc, f = 1.0 kHz)	AV3 _o	415	h _{fe}	100	400	hermal Re
Output Admittance (I _C = -1.0 mAdc, V _{CE} = -10 Vdc, f = 1.0 kHz)	28	081 + or 33 - 1	h _{oe}	3.0	60	μmhos
Noise Figure (I _C = -100μ Adc, V _{CE} = -5.0 Vdc , R _S = 1.0 k of	hm, f = 1.0) kHz)	NF	ELEG AL ISON	4.0	dB
SWITCHING CHARACTERISTICS						IV) JOHN COL
Delay Time $(V_{CC} = -3.0 \text{ Vdc}, V_{BE} = 0.5)$			t _d		35	ns
Rise Time $I_C = -10 \text{ mAdc}, I_{B1} = -1.0$	mAdc)	baron salamedan e	tr	con a nar	35	ns
Storage Time $(V_{CC} = -3.0 \text{ Vdc}, I_{C} = -10 \text{ m})$	Adc,		t _S	- T	225	ns
Fall Time $I_{B1} = I_{B2} = -1.0 \text{ mAdc}$			tf	_	75	ns

(1) Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	V _{CBO}	60	Vdc
Emitter-Base Voltage	V _{EBO}	6.0	Vdc
Collector Current — Continuous	Ic	600	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation	PD	300	mW
Alumina Substrate,** T _A = 25°C Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

DEVICE MARKING

MMBT4401LT1 = 2X

MMBT4401LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





SWITCHING TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

VIBT440TLTT = ZX		The state of the s			
ELECTRICAL CHARACTERISTICS (TA = 25	°C unless otherwise noted.)	R	Refer to 2N44	101 for grap	hs.
Characterist	tic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	sa otherwise noted.)	Inu SPES - ATT	SOUTHWEN	DAHAHO J	ADONTOEL
Collector-Emitter Breakdown Voltage(1) (IC =	1.0 mAdc, I _B = 0)	V(BR)CEO	40		Vdc
Collector-Base Breakdown Voltage (I _C = 0.1 n	nAdc, IE = 0)	V(BR)CBO	60	80(Y <u>21</u> 45)10	Vdc
Emitter-Base Breakdown Voltage (IE = 0.1 mA	Adc, I _C = 0)	V(BR)EBO	6.0	trier <u>B</u> reated	Vdc
Base Cutoff Current (VCE = 35 Vdc, VEB = 0.	4 Vdc)	IBEV	- ap <u>al</u> loV n	0.1	μAdc
Collector Cutoff Current (VCE = 35 Vdc, VEB	= 0.4 Vdc)	ICEX	d) analioV	0.1	μAdc
ON CHARACTERISTICS(1)	(657)	to, Veg = -0.4	V 36- = 30	A) Industry	Horus Bal
$(I_C = 1.0)$ $(I_C = 10)$ $(I_C = 150)$	mAdc, V _{CE} = 1.0 Vdc) mAdc, V _{CE} = 1.0 Vdc) mAdc, V _{CE} = 1.0 Vdc) 0 mAdc, V _{CE} = 1.0 Vdc) 0 mAdc, V _{CE} = 2.0 Vdc)	hFE 20 4	20 40 80 100 40	300	i Dagari Dagari Dagari Dagari
) mAdc, l _B = 15 mAdc)) mAdc, l _B = 50 mAdc)	V _{CE} (sat)		0.4 0.75	Vdc
	0 mAdc, I _B = 15 mAdc) 0 mAdc, I _B = 50 mAdc)	V _{BE(sat)}	0.75	0.95 1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS	evAde, ig = - 15 mAde)	08(+ = 50)	(f)lagalloly	Salamation	saim3-ea
Current-Gain — Bandwidth Product (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 100 MHz	(obAm.00 - ,= gf.coAm	fT	250	MATANO JAN	MHz
Collector-Base Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)		C _{cb}	top lad ydd e - 10 Vds	6.5	pF
Emitter-Base Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	(siffs 0.1 = 1.0	C _{eb}	= g (#) =0	30	pF
Input Impedance (I _C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	(sitt) 0.1 = 1 a	h _{ie}	1.0	15	k ohm
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	10 VBc, f = 1.0 kHz) = -10 VBc, f = 1.0 kHz	h _{re}	0.1	8.0	X 10-4
Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	(de, Y = 1.0 kHz)	h _{fe}	40	500	DUBERTATIV
Output Admittance ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	, obV	h _{oe}	1.0	30	μmhos
SWITCHING CHARACTERISTICS					
Delay Time (V _{CC} = 30 Vdc, V _{EB} = 2.0 Vdc,		t _d	1 UG 23	15	ns
Rise Time $I_C = 150 \text{ mAdc}, I_{B1}$	= 15 mAdc)	tr	0.00	20	ns
Storage Time (V _{CC} = 30 Vdc, I _C		t _S		225	ns
Fall Time $I_{B1} = I_{B2} = 15 \text{ mA}$	dc)	tf	_	30	ns

^{*}FR-5 = 1.0 x 0.75 x 0.062 in. **Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-40	Vdc
Collector-Base Voltage	VCBO	-40	Vdc
Emitter-Base Voltage	V _{EBO}	-5.0	Vdc
Collector Current — Continuous	Ic	-600	mAdc

THERMAL CHARACTERISITCS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		VAC 2.4	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT4403LT1 = 2T

MMBT4403LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





SWITCHING TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

Refer to 2N4402 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

	Cha	racteristic (0 = all abA	Symbol	Min	Max	Unit
OFF CHARACTERIST	ics	oeweevV (0 = al	onAm Lo = o) Voltage (i	wouther 9 o	a Geregoodk
Collector-Emitter Bre	eakdown Voltage(1)	$(I_C = -1.0 \text{ mAdc}, I_B = 0)$	V(BR)CEO	-40	Breen Cover	Vdc
Collector-Base Break	down Voltage (IC	= -0.1 mAdc, IE = 0	V(BR)CBO	-40	aV) memu	Vdc
Emitter-Base Breakdo	own Voltage (IE =	= -0.1 mAdc, I _C = 0)	V(BR)EBO	-5.0	off Current	Vdc
Base Cutoff Current	(V _{CE} = -35 Vdc	V _{EB} = -0.4 Vdc)	IBEV	_ (-0.1	μAdc
Collector Cutoff Curr	ent $(V_{CE} = -35)$	Vdc, V _{EB} = -0.4 Vdc)	ICEX	_	-0.1	μAdc
ON CHARACTERISTI	cs	% VCE = 1-0 Vde)	(16 = 1.0 mAd)			
DC Current Gain	100	$ \begin{array}{lll} (I_C = -0.1 \text{ mAdc, } V_{CE} = -1.0 \text{ Vdc}) \\ (I_C = -1.0 \text{ mAdc, } V_{CE} = -1.0 \text{ Vdc}) \\ (I_C = -10 \text{ mAdc, } V_{CE} = -1.0 \text{ Vdc}) \\ (I_C = -150 \text{ mAdc, } V_{CE} = -2.0 \text{ Vdc})(1) \\ (I_C = -500 \text{ mAdc, } V_{CE} = -2.0 \text{ Vdc})(1) \\ \end{array} $	Am 000 = 300 Am 000 = 300 Am 000 = 300 Am 000 = 300	30 60 100 100 20	300	nilector-En
Collector-Emitter Sat	turation Voltage(1)	(I _C = -150 mAdc, I _B = -15 mAdc) (I _C = -500 mAdc, I _B = -50 mAdc)	VCE(sat)	-getle)	-0.4 -0.75	Vdc
Base-Emitter Saturat	ion Voltage(1)	$(I_C = -150 \text{ mAdc}, I_B = -15 \text{ mAdc})$ $(I_C = -500 \text{ mAdc}, I_B = -50 \text{ mAdc})$	V _{BE(sat)}	-0.75 -	-0.95 -1.3	Vdc
SMALL SIGNAL CHA	RACTERISTICS		IsHM Dat	10 Vda, f =	= 35V.,obA	lg = 20 m
Current-Gain — Band (I _C = -20 mAdc,		= 100 MHz)	fT (s	200	se Ca pu chan) Vdo, Ig = 1	MHz
Collector-Base Capac	citance (V _{CB} = -	10 Vdc, IE = 0, f = 1.0 MHz)	C _{cb}		8.5	pF
Emitter-Base Capacit	tance $(V_{BE} = -0)$.5 Vdc, I _C = 0, f = 1.0 MHz)	Ceb	HW OLF SILV	30	pF
Input Impedance (Id	C = -1.0 mAdc, V	CE = -10 Vdc, f = 1.0 kHz)	hie	1.5k	15k	ohms
Voltage Feedback Ra	atio ($I_C = -1.0 \text{ m}$	Adc, V _{CE} = -10 Vdc, f = 1.0 kHz)	h _{re}	0.1	8.0	X 10-4
Small-Signal Current	t Gain ($I_C = -1.0$	mAdc, V _{CE} = -10 Vdc, f = 1.0 kHz)	h _{fe}	60	500	0.1 -01
Output Admittance	$(I_C = -1.0 \text{ mAdc})$	V _{CE} = -10 Vdc, f = 1.0 kHz)	hoe	1.0	100	μmhos
SWITCHING CHARAC	CTERISTICS		1.0 kHz	= 1 aby of	e goV abAh	0.f = gl
Delay Time	$(V_{CC} = -30 \text{ Vd})$	c, V _{FB} = -2.0 Vdc,	td		15	ns
Rise Time		ic, I _{B1} = -15 mAdc)	tr	1 (00 / 01	20	ns
Storage Time	$(V_{CC} = -30 \text{ Vd})$	c , $I_C = -150$ mAdc,	t _S	our i su	225	ns
Fall Time	$I_{B1} = I_{B2} = -1$		tf	10 - 33Y)	30	ns

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-50	Vdc
Collector-Base Voltage	V _{CBO}	-50	Vdc
Emitter-Base Voltage	V _{EBO}	-3.0	Vdc
Collector Current — Continuous	Ic	-50	mAdd

THERMAL CHARACTERISITCS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T _A = 25°C Derate above 25°C	PD	225	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{sta}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT5087LT1 = 2Q

MMBT5087LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





LOW NOISE TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

Refer to 2N5086 for graphs.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS			egarloV rev	otaland anii	na maalla
Collector-Emitter Breakdown Voltage (I _C = -1.0 mAdc, I _B = 0)	GROSTEMNA GROSTEMNA	V(BR)CEO	-50	-	Vdc
Collector-Base Breakdown Voltage $(I_C = -100 \mu Adc, I_E = 0)$	SSOCTSIALA GOOGLISHINA	V(BR)CBO	-50	F although	Vdc
Collector Cutoff Current $(V_{CB} = -10 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = -35 \text{ Vdc}, I_{E} = 0)$		ГСВО	Ξ	-10 -50	nAdc
ON CHARACTERISTICS					
DC Current Gain $(I_C = -100 \mu \text{Adc}, V_{CE} = -5.0 \text{Vdc})$ $(I_C = -1.0 \text{mAdc}, V_{CE} = -5.0 \text{Vdc})$ $(I_C = -10 \text{mAdc}, V_{CF} = -5.0 \text{Vdc})$	secare MM eroat shaw	hFE	250 250 250	800	(Hol=3V) (Hol03V) ARARO M
Collector-Emitter Saturation Voltage (I _C = -10 mAdc, I _B = -1.0 mAdc)	esparanim	VCE(sat)	V plane, 00	-0.3	Vdc
Base-Emitter Saturation Voltage (I _C = -10 mAdc, I _B = -1.0 mAdc)	BROSTEMM ESOSTSMM	V _{BE} (sat)	V ,gh4-m 0.	-0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS	génerres ava	India to the second	Al about		
Current-Gain — Bandwidth Product ($I_C = -500 \mu Adc, V_{CE} = -5.0 Vdc, f = 20 MHz$)	990878 MWI	fΤ	40		MHz
Output Capacitance (V _{CB} = -5.0 Vdc, I _E = 0, f = 1.0 MHz)	tabAm	C _{obo}	oltaga (fig	4.0	pF
Small-Signal Current Gain $(I_C = -1.0 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc}, f = 1.0 \text{ kHz})$		h _{fe}	250	900	is 2-mora
Noise Figure (I _C = -20 mAdc, V _{CE} = -5.0 Vdc, R _S = 10 k Ω , (I _C = -100 μ Adc, V _{CE} = -5.0 Vdc, R _S = 3.0 k Ω ,		NF Decrang tealing t	1,007 0.0 - 0 M 0.1 = 1	2.0 2.0	dB

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

		Va	lue	
Rating	Symbol	MMBT5088	MMBT5089	Unit
Collector-Emitter Voltage	VCEO	30	25	Vdc
Collector-Base Voltage	VCBO	35	30	Vdc
Emitter-Base Voltage	VEBO	4	.5	Vdc
Collector Current — Continuous	Ic	5	60	mAdd

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** TA = 25°C Derate above 25°C	PD	300	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT5088LT1 = 1Q; MMBT5089LT1 = 1R

MMBT5088LT1 MMBT5089LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





LOW NOISE TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

Refer to MPSA18 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

C	haracteristic	Libeton esignedia esta	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	lodgav8		pitroine there	dD Ch		
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	(G2D(RS)V	MMBT5088 MMBT5089	V(BR)CEO	30 25	CYERISTICS	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	оар(явіў	MMBT5088 MMBT5089	V _(BR) CBO	35 30	e projection de la company de	Vdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) (V _{CB} = 15 Vdc, I _E = 0)	0831	MMBT5088 MMBT5089	ІСВО	(0	50 50	nAdc
Emitter Cutoff Current (VEB(off) = 3.0 Vdc, I _C = 0) (VEB(off) = 4.5 Vdc, I _C = 0)	340	MMBT5088 MMBT5089	IEBO	W 0.=	50 100	nAdc
ON CHARACTERISTICS						
DC Current Gain ($I_C = 100 \mu Adc, V_C$	CE = 5.0 Vdc)	MMBT5088 MMBT5089	hFE	300 400	900 1200	Collector-E
(I _C = 1.0 mAdc, V _C	CE = 5.0 Vdc)	MMBT5088 MMBT5089		350 450	V noite u rsa 1 gl., ± Am 0	iase Emita Ng = -1
(I _C = 10 mAdc, V _C	gE = 5.0 Vdc)	MMBT5088 MMBT5089		300 400	NAL CHARAGO — Deodwigt	MALL SIG
Collector-Emitter Saturation Voltage	$(I_C = 10 \text{ mAdc}, I_B = 1.0)$	mAdc)	VCE(sat)	DV OE - H	0.5	Vdc
Base-Emitter Saturation Voltage (IC	= 10 mAdc, IB = 1.0 mA	(dc)	V _{BE(sat)}	0.7 - 5.0	0.8	Vdc
SMALL SIGNAL CHARACTERISTICS					Section 1	nol 2 Hazes
Current-Gain — Bandwidth Product (I _C = 500 μ Adc, V _{CE} = 5.0 Vdc, f	= 20 MHz)		(SHA) Of T = 1 ,	50	0 m /d s. Vgs	MHz
Collector-Base Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MH	dz emitter guarded)	(sHa 0.1 = 1	C _{cb}	= -5:0 Vot	4.0	pF)
Emitter-Base Capacitance (VEB = 0.5 Vdc, IC = 0, f = 1.0 MHz	Hz collector guarded)		C _{eb}	-	10	pF
Small Signal Current Gain (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f	= 1.0 kHz)	MMBT5088 MMBT5089	h _{fe}	350 450	1400 1800	-
Noise Figure (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, Ref = 1.0 kHz)	$s = 10 \text{ k}\Omega$,	MMBT5088 MMBT5089	NF	=	3.0 2.0	dB

Note: "LT1" must be used when ordering SOT-23 devices.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-150	Vdc
Collector-Base Voltage	VCBO	-160	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current — Continuous	Ic	-500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT5401LT1 = 2L

MMBT5401LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





HIGH VOLTAGE TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

Refer to 2N5401 for graphs.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS		Te-	LANGE STATE OF THE PARTY OF THE	alesta a de la consta	- votenile
Collector-Emitter Breakdown Voltage (I _C = -1.0 mAdc, I _B = 0)	CHRISTIAN CHARLEST	V(BR)CEO	- 150	mAd or ig = I	Vdc
Collector-Base Breakdown Voltage (I _C = -100 µAdc, I _E = 0)	MMeresso	V(BR)CBO	-160	ise Br e skdow a Add, Ig = 1	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc$, $I_C = 0$)	Maretessa	V(BR)EBO	-5.0	wyob featic s	Vdc
Collector Cutoff Current $(V_{CB} = -120 \text{ Vdc}, I_E = 0)$ $(V_{CB} = -120 \text{ Vdc}, I_E = 0, T_A = 100^{\circ}\text{C})$	gazarámin	СВО	_ (0	-50 -50	nAdc μAdc
ON CHARACTERISTICS	raserdram		10		
DC Current Gain	MAID USER	hFE	50 60 50	240	IVGS milliar Cest (VER + 4
Collector-Emitter Saturation Voltage ($I_C = -10 \text{ mAdc}$, $I_B = -1.0 \text{ mAdc}$) ($I_C = -50 \text{ mAdc}$, $I_B = -5.0 \text{ mAdc}$)	овистями	V _{CE(sat)}	196 V 0.8	-0.20 -0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = -10 \text{ mAdc}$, $I_B = -1.0 \text{ mAdc}$) ($I_C = -50 \text{ mAdc}$, $I_B = -5.0 \text{ mAdc}$)	PARTEMAN OCERTSMAN	V _{BE} (sat)	tal <u>v</u> s.e	-1.0 -1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS	PERFECTION				
Current-Gain — Bandwidth Product (I _C = -10 mAdc, V _{CE} = -10 Vdc, f = 100 MHz)	MMBTSSS:	fT	100	300	MHz
Output Capacitance (V _{CB} = -10 Vdc, I _E = 0, f = 1.0 MHz)	Both Types	C _{obo}	aget ial / no labAm 0.	6.0	pF
Small Signal Current Gain ($I_C = -1.0 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	0388TAHIM	h _{fe}	40	200	08 = <mark>5</mark> 0
Noise Figure $(I_C = -200 \mu Adc, V_{CE} = -5.0 \text{ Vdc}, R_S = 10 \text{ ohms}, f = 1.0 \text{ kHz})$	teny? fuod	NF	egation (shāra ti	8.0	dB

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	140	Vdc
Collector-Base Voltage	V _{CBO}	160	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	Ic	600	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT5550LT1 = M1F; MMBT5551LT1 = G1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





HIGH VOLTAGE TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

Refer to 2N5550 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Cha	racteristic	TOWNER SERVICE	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	lourryo		OUTER INSTANTANTA			
Collector-Emitter Breakdown Voltage(2) (IC = 1.0 mAdc, IB = 0)	253(88)V	MMBT5550 MMBT5551	V(BR)CEO	140 160	idens valin el pl <u>a</u> m 9	Vdc
$(I_C = 100 \ \mu Adc, I_E = 0)$	V/gen/cac	MMBT5550 MMBT5551	V(BR)CBO	160 180	ise Breakdol 00 <u>o Ad</u> el, Ig o Br ea kdown	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)	nesi		V _{(BR)EBO}	6.0	e pla <u>t</u> Aq b tarbuS hot	Vdc
		MMBT5550 MMBT5551 MMBT5550 MMBT5551	ІСВО	(0 = - p2 0 = -	100 50 100 50	nAdc μAdc
Emitter Cutoff Current (V _{EB} = 4.0 Vdc, I _C = 0)			IEBO	6V 0. 0− = 6V 0.å− =	50	nAdc
ON CHARACTERISTICS(2)						Collector-Er
DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc)	(mara6V	MMBT5550 MMBT5551 MMBT5550	hFE	60 80	250	$\begin{array}{rcl} - & & & & \\ - & & & \\ - & & & \\ - & & & \\ - & & & \\ - & & & \\ - & & & \\ - & & & \\ - & & & \\ - & & & \\ - & & & \\ - & & & \\ - & & & \\ - & & \\ - & & \\ - & & \\ - & & \\ - & & \\ - & & \\ - & & \\ - & & \\ - & & \\ - & & \\ - & & \\ - & & \\ - & & \\ - & & \\ - & \\ - & & \\ - &$
TO TIMAGE VCE SIG VAC		MMBT5551		80	250	HE TIVES
$(I_C = 50 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$	7	MMBT5550 MMBT5551	#HM 607 = 1	20 30	whose - o	DomanuO UC = -1
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)		Both Types	V _{CE(sat)}	0.1 -1.0	0.15	Vdc
$(I_C = 50 \text{ mAdc}, I_B = 5.0 \text{ mAdc})$	all	MMBT5550 MMBT5551	560 07 × 1.5	69 07 = = 10 Vol	0.25 0.20	ile = -1
Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)		Both Types	V _{BE} (sat)	W 0.8_ = ;	1.0	Vdc
$(I_C = 50 \text{ mAdc}, I_B = 5.0 \text{ mAdc})$		MMBT5550 MMBT5551		=	1.2 1.0	

(2) Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%. Note: "LT1" must be used when ordering SOT-23 devices.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	VCBO	40	Vdc
Emitter-Base Voltage	VEBO	12	Vdc
Collector Current — Continuous	Ic	500	mAdo

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T _A = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C

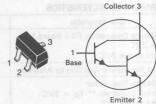
^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT6427LT1 = 1V

MMBT6427LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)



DARLINGTON TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Refer to 2N6426 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS				1940 217 137	SECTION AND
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, V _{BE} = 0)	EDMITEMM PENTENM	V _(BR) CEO	40	# gl.obAm	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	etastaina.	V(BR)CBO	40	Wóbalan Ber	Vdc
Emitter-Base Breakdown Voltage (I _C = 10 μ Adc, I _C = 0)	STABTEMM	V _{(BR)EBO}	12	l = g← bAm	Vdc
Collector Cutoff Current (V _{CE} = 25 Vdc, I _B = 0)		ICES	-	1.0	μAdc
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0)		СВО	- (50	nAdc
Emitter Cutoff Current (VEB = 10 Vdc, IC = 0)		IEBO	- (9	50	nAdc
ON CHARACTERISTICS				AGE (A	tennin (N.)
DC Current Gain (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) (I _C = 100 mAdc, V _{CE} = 5.0 Vdc) (I _C = 500 mAdc, V _{CE} = 5.0 Vdc)	ASMETRATA ESPECIAL MARTENZE	hFE	10,000 20,000 14,000	100,000 200,000 140,000	(lc = 0.0
Collector-Emitter Saturation Voltage ($I_C = 50 \text{ mAdc}$, $I_B = 0.5 \text{ mAdc}$) ($I_C = 500 \text{ mAdc}$, $I_B = 0.5 \text{ mAdc}$)		VCE(sat)*	5.0 <u>V</u> de)	1.2	Vdc
Base-Emitter Saturation Voltage ($I_C = 500 \text{ mAdc}, I_B = 0.5 \text{ mAdc}$)	SCA-C SMod	V _{BE(sat)}	tany na	2.0	Vdc
Base-Emitter On Voltage (I _C = 50 mAdc, V _{CE} = 5.0 Vdc)	MARKETERZE	V _{BE(on)}	apathoV no	1.75	Vdc
SMALL-SIGNAL CHARACTERISTICS			(anAm 8.	rolept, lig = 0	
Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}	Goewn Oc	7.0	pF
Input Capacitance (V _{EB} = 0.5, I _C = 0, f = 1.0 MHz)		Cibo	ZOTTERATIOS	15	pF
Current Gain — High Frequency ($I_C = 10 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$, $f = 100 \text{ MHz}$)		h _{fe}	1.3	i — Ba ndriiki mAda, Vog	Vdc
Noise Figure (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc, R_S = 100 k Ω , f = 1.0 kHz)		NF	HW 0.1 = 1.	10	dB

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

		Va	Value		
Rating	Symbol	MMBT6428	MMBT6429	Unit	
Collector-Emitter Voltage	VCEO	50	45	Vdc	
Collector-Base Voltage	VCBO	60	55	Vdc	
Emitter-Base Voltage	VEBO	6	.0	Vdc	
Collector Current — Continuous	Ic	2	00	mAdd	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT6428LT1 = 1KM; MMBT6429LT1 = 1L

MMBT6428LT1 MMBT6429LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPSA18 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Ch	aracteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) (I _C = 1.0 mAdc, I _B = 0)	Увянско	MMBT6428 MMBT6429	V(BR)CEO	50 45	nier Bjeskild Ado, Ver H	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1 \text{ mAdc}, I_E = 0$) ($I_C = 0.1 \text{ mAdc}, I_E = 0$)		MMBT6428 MMBT6429	V(BR)CBO	60 55	Acceptance of the second of th	Vdc
Collector Cutoff Current (VCE = 30 Vdc)	2331		ICES	-	0.1	μAdc
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0)	080		ІСВО		0.01	μAdc
Emitter Cutoff Current (VEB = 5.0 Vdc, I _C = 0)	O83 ¹		IEBO	_	0.01	μAdc
ON CHARACTERISTICS					Vdc, kg = 0)	n = 83 A)
DC Current Gain ($I_C = 0.01$ mAdc, $V_{CE} = 5.0$ Vdc) ($I_C = 0.1$ mAdc, $V_{CE} = 5.0$ Vdc) ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc)		MMBT6428 MMBT6429 MMBT6428 MMBT6429 MMBT6428 MMBT6429	hFE	250 500 250 500 250 500	650 1250	2 Carriers 1 (1 = 20) (1 = 20) (2 = 20) (2 = 20) (2 = 20) (2 = 20) (2 = 20) (3 = 20) (3 = 20) (3 = 20) (3 = 20) (4 = 20)
$(I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$	(no)38V	MMET6428 MMBT6429		250 500	ega Hring	se-Emitte
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 0.5 mAdc) (I _C = 100 mAdc, I _B = 5.0 mAdc)			V _{CE(sat)}	S.B V G.B TERRETRES	0.2 0.6	Vdc
Base-Emitter On Voltage (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc)			V _{BE(on)}	0.56	0.66	Vdc
SMALL-SIGNAL CHARACTERISTICS	001			(SHR) (C.F.	= 1.0 = old	1.0 = ggV
Current-Gain — Bandwidth Product (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f =	= 100 MHz)		f _T	100	700	MHz
Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz	z)		C _{obo}	5.0 Vdc, Re	3.0	pF
Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 1.0 MH	z)		C _{ibo}	Duly Cy	8.0	pF

Note: "LT1" must be used when ordering SOT-23 devices.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	350	Vdc
Collector-Base Voltage	VCBO	350	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Base Current	IB	250	mA
Collector Current — Continuous	IC	500	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT6517LT1 = 1Z

MMBT6517LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





HIGH VOLTAGE TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Refer to 2N6517 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

stell sets eins C	haracteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				correction of the	MARINO SHO
Collector-Emitter Breakdown Voltage (I _C = 1.0 mA)	OBD(RE) ^V	V(BR)CEO	350	placed regin	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μA)	ово(ва)У	V(BR)CBO	350	shine it sa	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μA)	У(ви)рво	V(BR)EBO	6.0	n Greakdowy	Vdc
Collector Cutoff Current (V _{CB} = 250 V)	icao i	ICBO		50	nA
Emitter Cutoff Current (VEB = 5.0 V)		I _{EBO}		50	nA
ON CHARACTERISTICS				SECURIO DE LA COMPANIO	Allaho MC
DC Current Gain		hFE	20 30 30 20 15	200 200	Themuo 30 (Ip = 4) (Ip = 7) (Ip = 2) (Ip = 3)
Collector-Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) (I _C = 20 mA, I _B = 2.0 mA) (I _C = 30 mA, I _B = 3.0 mA) (I _C = 50 mA, I _B = 5.0 mA)	(fail)30 ^V	VCE(sat)*	tion Voltage -1.0 mA) -2.0 mA) -3.0 mA)	0.30 0.35 0.50 1.0	Vdc
Base-Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) (I _C = 20 mA, I _B = 2.0 mA) (I _C = 30 mA, I _B = 3.0 mA)	Usel38 ^V	V _{BE} (sat)	Voltage (A/R 0.1) (A/R 0.1) (A/R 0.1)	0.75 0.85 0.90	Vdc
Base-Emitter On Voltage (I _C = 100 mA, V _{CE} = 10 V)		V _{BE(on)}	0/01	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS			CITEMETICS	AEAHO JAN	DE-JAME
Current-Gain — Bandwidth Product (I _C = 10 mA, V _{CE} = 20 V, f = 20	MHz)	f _T	40	200	MHz
Collector-Base Capacitance (V _{CB} = 20 V, f = 1.0 MHz)	Ceb	C _{cb}	apr IsHM 0	6.0	pF
Emitter-Base Capacitance (VFR = 0.5 V, f = 1.0 MHz)	de ³	C _{eb}	10104.0	80	pF

*Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-350	Vdc
Collector-Base Voltage	VCBO	-350	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Base Current	IB	-250	mA
Collector Current — Continuous	IC.	-500	mAdo

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW/°C
Derate above 25°C		1.8	mvv/ C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300	mW mW/°C
CONTRACTOR STATES AND ADDRESS.			
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT6520LT1 = 2Z

MMBT6520LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





HIGH VOLTAGE TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

Refer to 2N6520 for graphs.

Ch	aracteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				OH BIRETOAR	AND THE
Collector-Emitter Breakdown Voltage (I _C = -1.0 mA)	VERICEO	V(BR)CEO	-350	Amriler Break	Vdc
Collector-Base Breakdown Voltage (I _C = -100 μA)	085(88)V	V(BR)CBO	-350	(Au D	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu A$)	V(BR)EBO	V(BR)EBO	-5.0	Votes <u>so</u> ve na (Art	Vdc
Collector Cutoff Current (V _{CB} = -250 V)	(680	ICBO		-50	nA
Emitter Cutoff Current (VEB = -4.0 V)	0831	IEBO	-	-50	nA
ON CHARACTERISTICS				ACTERISTICS	NAME OF A
DC Current Gain $ \begin{aligned} &(I_C = -1.0 \text{ mA, V}_{CE} = -10 \text{ V}) \\ &(I_C = -10 \text{ mA, V}_{CE} = -10 \text{ V}) \\ &(I_C = -30 \text{ mA, V}_{CE} = -10 \text{ V}) \\ &(I_C = -30 \text{ mA, V}_{CE} = -10 \text{ V}) \\ &(I_C = -50 \text{ mA, V}_{CE} = -10 \text{ V}) \end{aligned} $	990	hFE	20 30 30 20 15	200 200 —	(16 = 10 (16 = 10 (16 = 20 (16 = 20 (16 = 50 (16 = 50
Collector-Emitter Saturation Voltage $(I_C = -10 \text{ mA}, I_B = -1.0 \text{ mA})$ $(I_C = -20 \text{ mA}, I_B = -2.0 \text{ mA})$ $(I_C = -30 \text{ mA}, I_B = -3.0 \text{ mA})$ $(I_C = -50 \text{ mA}, I_B = -5.0 \text{ mA})$	*(ce)32*	VCE(sat)	Am (Am (Am (Am (LAm (- 0.30 - 0.35 - 0.50 - 1.0	Vdc
Base-Emitter Saturation Voltage ($I_C = -10 \text{ mA}$, $I_B = -1.0 \text{ mA}$) ($I_C = -20 \text{ mA}$, $I_B = -2.0 \text{ mA}$) ($I_C = -30 \text{ mA}$, $I_B = -3.0 \text{ mA}$)	(168)38 ^W	V _{BE} (sat)	Am (Am (Am (Am (-0.75 -0.85 -0.90	Vdc
Base-Emitter On Voltage (I _C = -100 mA, V _{CE} = -10 V)	(Ap)98V	V _{BE(on)}	[V 01	-2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS			EN FEIRATO/	ARAND JAVID	a Junia
Current-Gain — Bandwidth Product ($I_C = -10 \text{ mA}, V_{CE} = -20 \text{ V}, f =$	20 MHz)	f _T	40	200	MHz
Collector-Base Capacitance (V _{CB} = -20 V, f = 1.0 MHz)	da ^Q	C _{cb}	MH/z)	6.0	pF
Emitter-Base Capacitance (VEB = -0.5 V, f = 1.0 MHz)	deD	C _{eb}	(x)-(3/)	100	pF

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-80	V
Collector-Base Voltage	V _{CBO}	-80	V
Emitter-Base Voltage	VEBO	-5.0	V
Collector Current — Continuous	Ic	-500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300	mW/°C
	D	Marin I	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta}JA$	417	C/VV
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBT8599LT1 = 2W

MMBT8599LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N4125 for graphs.

Mux Mark	Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS			STATE AND		orensmos	OFF CHASE
Collector-Emitter Breakdown Voltag (I _C = -10 mAdc, I _E = 0)	e(1)	MARTAGE	V(BR)CEO	- 80	oine - B reakdo mAdo, Ig = 1	Vdc
Collector-Base Breakdown Voltage $(I_C = -100 \mu Adc, I_E = 0)$	У(вя)язо	MMBTAOR	V(BR)CBO	-80 sperioV	rwobisei5 s	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc, I_C = 0$)	easi		V(BR)EBO	-5.0	menta to = (Vdc
Collector Cutoff Current (VCB = -80 Vdc, I _E = 0)	osol		ICBO	- 1	-100	nAdc
Emitter Cutoff Current (VEB = -4.0 Vdc, I _C = 0)		ANNETAGE MMETAGE	IEBO	-	-100	nAdc
ON CHARACTERISTICS					CTEMBTICS	ON CHARA
DC Current Gain(1) $(I_C = -1.0 \text{ mAdc}, V_{CE} = -5.0 \text{ V})$ $(I_C = -10 \text{ mAdc}, V_{CE} = -5.0 \text{ V})$ $(I_C = -100 \text{ mAdc}, V_{CE} = -5.0 \text{ V})$	dc)		hFE	100 100 75	300	The second contract of the second
Collector-Emitter Saturation Voltage ($I_C = -100 \text{ mAdc}$, $I_B = -10 \text{ mA}$ ($I_C = -100 \text{ mAdc}$, $I_B = -5.0 \text{ mA}$	dc)		VCE(sat)		måde, lg =	
Base-Emitter On Voltage(1) (I _C = -10 mAdc, V _{CE} = 5.0 V)			V _{BE(on)}	-0.6	-0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS			(sittle)	101 = 1 W O.	mA. Ver = 2	07 = 50
Current-Gain – Bandwidth Product ($I_C = -10$ mAdc, $V_{CE} = -5.0$ Vo	dc, f = 100 MHz)	JAL olases to unity.	alafto ymo	150	tibiW onic4 ::	MHz
Input Capacitance (VEB = -0.5 Vdc, I _C = 0, f = 1.0) MHz)	iosa.	Cibo			
Collector-Base Capacitance (V _{CB} = -5.0 Vdc, I _E = 0, f = 1.0) MHz)		C _{cb}	-	4.5	pF

⁽¹⁾ Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

Rating	Symbol	MMBTA05	MMBTA06	Unit
Collector-Emitter Voltage	VCEO	60	80	Vdc
Collector-Base Voltage	VCBO	60	80	Vdc
Emitter-Base Voltage	VEBO	4.0		Vdc
Collector Current — Continuous	lc	500		mAdd

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBTA05LT1 = 1H; MMBTA06LT1 = 1GM

MMBTA05LT1 MMBTA06LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





DRIVER TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

thu was nim c	haracteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS				8	OFFERENCE	HAKO TRO
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	V(BR)CE((I)	MMBTA05 MMBTA06	V(BR)CEO	60 80	leone nation al Albam Di state To sea	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)	nearestV		V _{(BR)EBO}	4.0	190 <u>j. A</u> dd, lg se Sresidov	Vdc
Collector Cutoff Current (VCE = 60 Vdc, IB = 0)	neol		ICES	_ (0 -	0.1	μAdc
Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 80 Vdc, I _E = 0)	083	MMBTA05 MMBTA06	ІСВО	(0 =	0.1 0.1	μAdc
ON CHARACTERISTICS					EDITE HETO	ON CHARA
DC Current Gain (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc)	. 341		hFE	100	(AlmisO (Commidg, V (Commid)	10 = 30 10 = = 10 = =
Collector-Emitter Saturation Voltage ($I_C = 100 \text{ mAdc}$, $I_B = 10 \text{ mAdc}$)	transmV		V _{CE(sat)}	cg « 5,6 /	0.25	Vdc
Base-Emitter On Voltage (IC = 100 mAdc, VCE = 1.0 Vdc)			V _{BE(on)}	Am 0 <u>1 = </u>	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS	VBB(on)			(1)as	eriov no te	Hand-mass
Current-Gain — Bandwidth Product(2 (I _C = 10 mA, V _{CE} = 2.0 V, f = 10)	•		fT	100	BAHO JAH	MHz

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Note: "LT1" must be used when ordering SOT-23 devices.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCES	30	Vdc
Collector-Base Voltage	V _{CBO}	30	Vdc
Emitter-Base Voltage	V _{EBO}	10	Vdc
Collector Current — Continuous	Ic	300	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit	
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C	PD	225	mW	
Derate above 25°C		1.8	mW/°C	
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W	
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW	
Derate above 25°C		2.4	mW/°C	
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W	
Junction and Storage Temperature	TJ, T _{sta}	-55 to +150	°C	

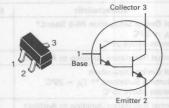
^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBTA13LT1 = 1M; MMBTA14LT1 = 1N

MMBTA13LT1 MMBTA14LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)



DARLINGTON AMPLIFIER TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

Refer to 2N6426 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

MINU CI	haracteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					OF EARLY LOAD	MARD YAU
Collector-Emitter Breakdown Voltage ($I_C = 100 \mu Adc, V_{BE} = 0$)	OSU(BB)VEO		V(BR)CES	30	e pi poArn	Vdc
Collector Cutoff Current (VCB = 30 Vdc, IE = 0)	QB3(RB)V		ІСВО	Notinge (0)	100	nAdc
Emitter Cutoff Current (VEB = 10 Vdc, I _C = 0)	OBOL		IEBO	(0	100	nAdc
ON CHARACTERISTICS(1)					SOLLS HELD!	CHAIL
DC Current Gain ($I_C = 10 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$) ($I_C = 100 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$)	VCE(33t)	MMBTA13 MMBTA14 MMBTA13	hFE	5000 10,000		Grictaello3 07 = 30
(IC = 100 MAde, VCE = 5.0 Vde)		MMBTA14		20,000	RALT JAIT	SMALL-SU
Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 0.1 mAdc)	T		V _{CE} (sat)	= 10 vdc, f	1.5	Vdc
Base-Emitter On Voltage (IC = 100 mAdc, VCE = 5.0 Vdc)	9300		V _{BE}	M 0, F = 1,0	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product(2 (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f =	· Commence of the commence of		fT	125		MHz

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

(2) fT = |hfe| * ftest· Note: "LT1" must be used when ordering SOT-23 devices.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Emitter-Base Voltage	V _{EBO}	4.0	Vdc
Collector Current — Continuous	lc	100	mAdd

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBTA20LT1 = 1C

MMBTA20LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





GENERAL PURPOSE AMPLIFIER

NPN SILICON

Refer to MPS3904 for graphs.

Characteristic		Symbol	Min	Max	Unit	
OFF CHARACTERISTICS					antemato.	nako sao
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	Y(sh)ces		V _(BR) CEO	40	hitama auto	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)	oao!		V _{(BR)EBO}	4.0	noff Conent	Vdc
Collector Cutoff Current (VCB = 30 Vdc, IE = 0)	089		СВО	-	100	nAdc
ON CHARACTERISTICS				15	MORRAGATO	ARIANO MO
DC Current Gain (IC = 5.0 mAdc, VCE = 10 Vdc)	99/	FIZTOMA	hFE	40	400	Current
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)		MMSTA14	V _{CE(sat)}	-	0.25	Vdc
SMALL-SIGNAL CHARACTERISTICS		STATUMM		(55V 0.8 =	BOV JOAN	101 = 301
Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 10 Vdc, f =	= 100 MHz)		fΤ	125	nitter Sawara	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MH	z) 34V		C _{obo}	_	4.0	pF

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	MMBTA42	MMBTA43	Unit
Collector-Emitter Voltage	VCEO	300	200	Vdc
Collector-Base Voltage	VCBO	300	200	Vdc
Emitter-Base Voltage	VEBO	6.0 6.0		Vdc
Collector Current — Continuous	Ic Ic	500		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{stg}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBTA42LT1 = 1D; MMBTA43LT1 = M1E

MMBTA42LT1* MMBTA43LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





HIGH VOLTAGE TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

Refer to MPSA42 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS				вопъизгол	FAHO TH
Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0)	MMBTA42 MMBTA43	V(BR)CEO	300 200	mitter Breskfr 1.0 m /s tc. lg	Vdc
Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0)	MMBTA42 MMBTA43	V(BR)CBO	300 200	o Bresident	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \mu Adc, I_C = 0$)		V _{(BR)EBO}	6.0	e gl. 0 51 / 03-	Vdc
Collector Cutoff Current $(V_{CB} = 200 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = 160 \text{ Vdc}, I_{E} = 0)$	MMBTA42 MMBTA43	Ісво	— (0 — (0	0.1 0.1	μAdc
Emitter Cutoff Current (VEB = 6.0 Vdc, I _C = 0) (VEB = 4.0 Vdc, I _C = 0)	MMBTA42 MMBTA43	IEBO	5V 0:T− ¥	0.1 0.1	μAdc
ON CHARACTERISTICS(1)			anuthol/ no	Name 2 miles	Lastrolla
DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc)	Both Types Both Types	h _{FE}	25 40	on made, fg er On Voltaga too made, V	e je g l) din Jose – e ol)
(I _C = 30 mAdc, V _{CE} = 10 Vdc)	MMBTA42 MMBTA43	0	40 40	NAL CHARAC	AZ JAM Danamu
Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc)	MMBTA42 MMBTA43	VCE(sat)	V 0.1 - = ; ,ea; 1 00. ≥ w se - Cone p	0.5 0.5	Vdc
Base-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc)		V _{BE(sat)}	abro ce rtw	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)		fT	50	-	MHz
Collector-Base Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 1.0 MHz)	MMBTA42 MMBTA43	C _{cb}	_	3.0 4.0	pF

(1) Pulse Test: Pulse Width \le 300 μ s, Duty Cycle \le 2.0%. Note: "LT1" must be used when ordering SOT-23 devices.

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

Rating	Symbol	MMBTA55	MMBTA56	Unit
Collector-Emitter Voltage	VCEO	-60	-80	Vdc
Collector-Base Voltage	VCBO	-60	-80	Vdc
Emitter-Base Voltage	VEBO	-4.0		Vdc
Collector Current — Continuous	lc	obAm -	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{sta}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBTA55LT1 = 2H; MMBTA56LT1 = 2GM

MMBTA55LT1 MMBTA56LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





DRIVER TRANSISTORS

PNP SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS				ETIT SIRE TO A	SAND THO
Collector-Emitter Breakdown Voltage(1) (I _C = -1.0 mAdc, I _B = 0)	MMBTA55 MMBTA56	V(BR)CEO	-60 -80	hitter Break m.\d - _3 =	Vdc
Emitter-Base Breakdown Voltage $(I_E = -100 \mu Adc, I_C = 0)$		V(BR)EBO	-4.0	ne B—sdor	Vdc
Collector Cutoff Current (VCE = -60 Vdc, I _B = 0)	2001/01/01/01	ICES	egurtoV	-0.1	μAdc
Collector Cutoff Current $(V_{CB} = -60 \text{ Vdc}, I_E = 0)$ $(V_{CB} = -80 \text{ Vdc}, I_E = 0)$	MMBTA55 MMBTA56	ІСВО		-0.1 -0.1	μAdc
ON CHARACTERISTICS	\$4MTEMM		(0	= Bi box co	= BOVI
DC Current Gain (I _C = -10 mAdc, V _{CE} = -1.0 Vdc) (I _C = -100 mAdc, V _{CE} = -1.0 Vdc)	SKATBIAM ERATEMM	hFE	100 100	00 Vdg 1g = 1.0 Vdg 1g =	IVES = (VES = (
Collector-Emitter Saturation Voltage (I _C = -100 mAdc, I _B = -10 mAdc)		VCE(sat)	_ (8)	-0.25	Vdc
Base-Emitter On Voltage (I _C = -100 mAdc, V _{CE} = -1.0 Vdc)	Both Types Both Types	V _{BE(on)}	(36V 0) =	-1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS	MMBTA42		nist or =	anV.ab/m	(Ic = 30
Current-Gain — Bandwidth Product(2) (I _C = -100 mAdc, V _{CF} = -1.0 Vdc, f = 100 MHz)	WW8TA43	fT	50	anutail namin	MHz

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Note: "LT1" must be used when ordering SOT-23 devices.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCES	-30	Vdc
Collector-Base Voltage	V _{CBO}	-30	Vdc
Emitter-Base Voltage	VEBO	——————————————————————————————————————	Vdc
Collector Current — Continuous	Ic	-500	mAdo

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tstq	-55 to +150	°C

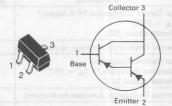
^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBTA63LT1 = 2U; MMBTA64LT1 = 2V

MMBTA63LT1 MMBTA64LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)



DARLINGTON TRANSISTORS

PNP SILICON

★This is a Motorola
designated preferred device.

Refer to MPSA75 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

	Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					80/Testino	SAAHD 1110
Collector-Emitter Breakdown Vo ($I_C = -100 \mu Adc$)	Itage COORBY		V(BR)CES	-30	nitter <u>Er</u> eafrik 8 mAlfo, 18 -	Vdc
Collector Cutoff Current (V _{CB} = -30 Vdc)	Viemereo		ІСВО	eosifoV (0)	-100	nAdc
Emitter Cutoff Current (VEB = -10 Vdc)			IEBO	- 10	-100	nAdc
ON CHARACTERISTICS					SCH SHEET	ARAHO MO
DC Current Gain (1) (IC = -10 mAdc, VCE = -5 . (IC = -10 mAdc, VCE = -5 . (IC = -100 mAdc, VCE = $-\frac{5}{2}$. (IC = -100 mAdc, VCE = $-\frac{5}{2}$.	0 Vdc) 5.0 Vdc)	MMBTA63 MMBTA64 MMBTA63 MMBTA64	hFE	5,000 10,000 10,000 20,000	Sale Comade Vog other Sounal maker, type	nesr <u>uo</u> 30 E = 20 E-10testoo C = 20)
Collector-Emitter Saturation Vol. $(I_C = -100 \text{ mAdc}, I_B = -0.1)$			V _{CE} (sat)	th Product	-1.5	Vdc
Base-Emitter On Voltage $(I_C = -100 \text{ mAdc}, V_{CE} = -5)$	5.0 Vdc)		V _{BE} (on)		-2.0	Vdc
SMALL-SIGNAL CHARACTERIST	rics			1 201		9377
Current-Gain — Bandwidth Proc ($I_C = -10$ mAdc, $V_{CE} = -5$.			fT	125		MHz

(1) Pulse Test: Pulse Width \le 300 μ s, Duty Cycle \le 2.0%. Note: "LT1" must be used when ordering SOT-23 devices.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	slav -40	Vdc
Emitter-Base Voltage	V _{EBO}	-4.0	Vdc
Collector Current — Continuous	Ic	- 100	mAdo

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBTA70LT1 = M2C

MMBTA70LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AA)





GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N5086 for graphs.

Char	racteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					EDIT SWETO	ARAHO TIO
Collector-Emitter Breakdown Voltage (I _C = -1.0 mAdc, I _B = 0)	Viexices		V _(BR) CEO	sgs-40	objes ta retti O "Ado)	Vdc
Emitter-Base Breakdown Voltage ($I_E = -100 \mu Adc, I_C = 0$)	0801		V _{(BR)EBO}	-4.0	sher til) Hot 30 Vdk)	Vdc
Collector Cutoff Current (V _{CB} = -30 Vdc, I _E = 0)	083		ІСВО	-	-100	nAdc
ON CHARACTERISTICS					garring r	DARAHO MO
DC Current Gain $(I_C = -5.0 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})$	34t	LAATEMM	hFE	40	400	men = 00 (= 00
Collector-Emitter Saturation Voltage ($I_C = -10 \text{ mAdc}$, $I_B = -1.0 \text{ mAdc}$)		NATEMM EBATEMM	V _{CE} (sat)	- 5.0 Vdc		Vdc
SMALL-SIGNAL CHARACTERISTICS		POWIGININ		10 A & B	30x aupor u	3 30
Current-Gain — Bandwidth Product (I _C = -5.0 mAdc, V _{CE} = -10 Vdc, 1	= 100 MHz)		fT	125	e gl. otakin 0	MHz
Output Capacitance (VCB = -10 Vdc, IE = 0, f = 1.0 MH	lz)		C _{obo}	6V 0.8- =	4.0	pF

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	MMBTA92	MMBTA93	Unit
Collector-Emitter Voltage	VCEO	-300	-200	Vdc
Collector-Base Voltage	VCBO	-300	-200	Vdc
Emitter-Base Voltage	VEBO	-5.0	-5.0	Vdc
Collector Current — Continuous	Ic	-500		mAdd

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_{A} = 25^{\circ}C$	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tsta	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBTA92LT1 = 2D; MMBTA93LT1 = 2E

MMBTA92LT1* MMBTA93LT1

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





HIGH VOLTAGE TRANSISTORS

PNP SILICON

★This is a Motorola designated preferred device.

Refer to MPSA92 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

zinU xxiV niM Ch	aracteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					CONTEMPORAL	AND THO
Collector-Emitter Breakdown Voltage (I _C = -1.0 mAdc, I _B = 0)	1)030(RS)V	MMBTA92 MMBTA93	V(BR)CEO	-300 -200	mAd <u>u</u> tg = 1 mAd <u>u</u> tg = 1	Vdc
Collector-Base Breakdown Voltage $(I_C = -100 \mu Adc, I_E = 0)$	O83(96)V	MMBTA92 MMBTA93	V(BR)CBO	-300 -200	ABC, 1g = e e Ere Historian ABC His = 0	Vdc
Emitter-Base Breakdown Voltage (I _E = -100 μAdc, I _C = 0)	080		V(BR)EBO	-5.0	aph Gyrem 5 Vdc. Ig = 1	Vdc
Collector Cutoff Current (VCB = -200 Vdc, IE = 0) (VCB = -160 Vdc, IE = 0)	683	MMBTA92 MMBTA93	ICBO	_ 8	- 0.25 - 0.25	μAdc
Emitter Cutoff Current (VEB = -3.0 Vdc, I _C = 0)	310		I _{EBO}	List of	-0.1	μAdc
ON CHARACTERISTICS(1)				naminal set	Marian O and	G secondle
DC Current Gain		Both Types Both Types	hFE	25 40	mAde, lg = l c Ge Voltage cnAcc, Vos	(16 = 4.0 (16 = 4.0
$(I_C = -30 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})$		MMBTA92 MMBTA93		25 25	ARXID JAN	DEE-JAME
Collector-Emitter Saturation Voltage ($I_C = -20$ mAdc, $I_B = -2.0$ mAdc	Cep	MMBTA92 MMBTA93	VCE(sat)	10 Vds, f	-0.5 -0.5	Vdc
Base-Emitter Saturation Voltage (IC = -20 mAdc, IB = -2.0 mAdc) 612		V _{BE(sat)}	Capilottania	-0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS	The state			triali	en Tiere Com	allector Ba
Current-Gain — Bandwidth Product (I _C = -10 mAdc, V _{CE} = -20 Vdc,	f = 100 MHz)		f _T 8 /8	50	801-ham	MHz
Collector-Base Capacitance $(V_{CB} = -20 \text{ Vdc}, I_E = 0, f = 1.0 \text{ N})$	1Hz)	MMBTA92 MMBTA93	C _{cb}	=	6.0 8.0	pF

(1) Pulse Test: Pulse Width \le 300 μ s, Duty Cycle \le 2.0%. Note: "LT1" must be used when ordering SOT-23 devices.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	25	Vdc
Collector-Base Voltage	V _{CBO}	30	Vdc
Emitter-Base Voltage	V _{EBO}	3.0	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{sta}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBTH10LT1 = 3EM

MMBTH10LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





VHF/UHF TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Refer to MPSH10 for graphs.

steel cold CI	naracteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					apriala roa	FF CHAR
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	V(BRICED	SPATRIAM	V _(BR) CEO	25	ole so b T ostim at abAm 0.	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	Vagagaga	ERATSMM	V _(BR) CBO	30	ngbiser8 and	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)		MASSTAB2 MASTASS	V _{(BR)EBO}	3.0	31 AUE 4 00	Vdc
Collector Cutoff Current (VCB = 25 Vdc, IE = 0)	Онациану		СВО	n <u>es</u> rfoV (0 =	100	nAdc
Emitter Cutoff Current (VEB = 2.0 Vdc, I _C = 0)	080	SEATSMM	IEBO	-(0 =	100	nAdc
ON CHARACTERISTICS		SHA LENGTH		14	di non not	2.8037
DC Current Gain (I _C = 4.0 mAdc, V _{CE} = 10 Vdc)	088		hFE	60	3.0 700.10	= 8AA)
Collector-Emitter Saturation Voltage (I _C = 4.0 mAdc, I _B = 0.4 mAdc)	338		V _{CE} (sat)		0.5	Vdc
Base-Emitter On Voltage (I _C = 4.0 mAdc, V _{CE} = 10 Vdc)		Both Types	V _{BE}	bbV 01	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS		MMBTA92		abV 01 - =	my Vabarra 0	E- = 00
Current-Gain — Bandwidth Product (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f =	100 MHz)	CBATBIMIN	fT	650	mitter Sarapa	MHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MH	z)	MMBTA93 MMBTA93	C _{cb}	(p/An) <u>0 S</u>	0.7	pF
Common-Base Feedback Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MH			C _{rb}	ADBITOV DAM 0.5 -	0.65	pF
Collector Base Time Constant (IC = 4.0 mAdc, VCB = 10 Vdc, f =	= 31.8 MHz)		rb'C _C	in Product	9.0	ps
			Tel-Mil (107 to 1	35W 15 - 11	DANG CONTROLS	

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	30	Vdc
Collector-Base Voltage	VCBO	40	Vdc
Emitter-Base Voltage	VEBO	4.0	Vdc
Collector Current — Continuous	Ic	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBTH24LT1 = M3A

MMBTH24LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





VHF MIXER TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Chara	acteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS		Lienon asiwa	28°C ualess relyc	- An 200	ACTERIST	CAL CRAP	INTOBALE
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	rsIM.	lottoyii	V(BR)CEO	30	13 -	-	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	11-	Q30(R8) ^y	V(BR)CBO	40	aV nwobks	viti raminis	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)	ar-	овојяву	V(BR)EBO	4.0	ssloV nwot	frend nest	Vdc
Collector Cutoff Current (VCB = 15 Vdc, IE = 0)	4.0	одз(йв)У	ІСВО	-	gatto V russ	50	nAdc
ON CHARACTERISTICS					bis	man di din an	verselle.
DC Current Gain (I _C = 8.0 mAdc, V _{CE} = 10 Vdc)			hFE	30	l v − 3	ant - r-	= 80 74)
SMALL-SIGNAL CHARACTERISTICS	est.					Lelect b	sames se
Current-Gain — Bandwidth Product(1) (I _C = 8.0 mAdc, V _{CE} = 10 Vdc, f =		z)	fT	400	620	Sh/ - Of	MHz
Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MH	z)	1 1	C _{cb}	2013 - 1013	0.25	0.45	pF
Conversion Gain (213 MHz to 45 MHz) (IC = 8.0 mAdc, VCC = 20 Vdc, C (60 MHz to 45 MHz) (IC = 8.0 mAdc, VCC = 20 Vdc, C			- C _G	19	24	eqs() esse (at/V 01 -	dB

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

• Designed for UHF/VHF Amplifier Applications

High Current Gain Bandwidth Product
 f_T = 2000 MHz Min @ 10 mA

MAXIMUM RATINGS

MAXIMOM HATINGO					
Rating	Symbol	Value	Unit		
Collector-Emitter Voltage	VCEO	-15	Vdc		
Collector-Base Voltage	V _{CBO}	-15	Vdc		
Emitter-Base Voltage	V _{EBO}	-4.0	Vdc		

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBTH69LT1 = M3J

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	OBDISHIV T	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS				19		1 = 91
Collector-Emitter Breakdown Voltage (I _C = -1.0 mAdc, I _B = 0)	Q83(86)Y	V(BR)CEO	-15	District of the	at obAu 0	Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc$, $I_E = 0$)	GRE(NE)*	V _(BR) CBO	- 15	ingenov n	= 31 26Aq	Vdc
Emitter-Base Breakdown Voltage (IE = $-10 \mu Adc$, IC = 0)	Oed!	V _{(BR)EBO}	-4.0	T (0	18 V do. 1g ni	Vdc
Collector Cutoff Current (V _{CB} = -10 Vdc, I _E = 0)	200	ICBO	_		-100	nAdc
ON CHARACTERISTICS				1294 01 =	TO SUZUB D	8 - 30
DC Current Gain $(I_C = -10 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})$	70	hFE	30	potent tita	300	E JETTO YELL
SMALL-SIGNAL CHARACTERISTICS			THUS DOT -	any or -	TO PROPERTY	a = 3#
Current-Gain — Bandwidth Product $(I_C = -10 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}, f = -10 \text{ Vdc})$	100 MHz)	fΤ	2000	No.r T 1.6	= 28,50 / Dt	MHz
Collector-Base Capacitance (VCF = -10 Vdc, IF = 0, f = 1.0 MHz)		C _{rb}	-	-	0.35	pF

MMBTH69LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





UHF/VHF TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-20	Vdc
Collector-Base Voltage	VCBO	-20	Vdc
Emitter-Base Voltage	VEBO	-3.0	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit	
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW	
Derate above 25°C	1 3	V 1.8	mW/°C	
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W	
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300	mW/°C	
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W	
Junction and Storage Temperature	TJ, T _{sta}	-55 to +150	°C	

^{*}FR-5 = 1.0 x 0.75 x 0.062 in.

DEVICE MARKING

MMBTH81LT1 = 3D

MMBTH81LT1*

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)





UHF/VHF TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

Characteris	stic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	88	Vigoros	MPG2122	M (1)	sperioV nwob:	Smitter Break	l-noreaffol
Collector-Emitter Breakdown Voltage	09		V(BR)CEO	-20	(6.	e gl <u>ab</u> Am (Vdc
$(I_C = -1.0 \text{ mAdc}, I_B = 0)$	08	Vicinion	WEQ2022	M	ansilaV awa	Base Breakd	rofaello
Collector-Base Breakdown Voltage			V _{(BR)CBO}	-20	(0	mg JahAn (Vdc
$(I_C = -10 \mu Adc, I_E = 0)$	6.8	Vibracio			assitoV ev	se Breakdov	S-remin
Emitter-Base Breakdown Voltage (I _E = -10μ Adc, I _C = 0)			V(BR)EBO	-3.0	(0) _A Ad <u>a.</u> I <u>C</u> = Sutoff Currer	Vdc
Collector Cutoff Current (VCB = -10 Vdc, I _E = 0)			ICBO	M — M	— (0 (0.	- 100	nAdc
Emitter Cutoff Current (VEB = -2.0 Vdc, IC = 0)		G83 ¹	IEBO		- (0 -	-100	nAdc
ON CHARACTERISTICS						ACTERISTICS	RARD ME
DC Current Gain (I _C = -5.0 mAdc, V _{CE} = -10 Vdc)	36	334	hFE ASSSSORM	60	10 V)	t Gal a (1) 10 μΑ, VcB =	10 Dune (10 = 1
Collector-Emitter Saturation Voltage (I _C = -5.0 mAdc, I _B = -0.5 mAdc)	76		VCE(sat)	M M	10.01	-0.5	Vdc
	100		V _{BE(on)}	M -	₩ 01 ×	-0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS	30		MP02222	M	(A.Q.) -	D mA, VCE	E = Ol
Current-Gain — Bandwidth Product (I _C = -5.0 mAdc, V _{CE} = -10 Vdc, f	= 100 MH	z)	A STISSON	600	(V 0.1 -	BOV Am 0	MHz
Collector-Base Capacitance (VCB = -10 Vdc, I _E = 0, f = 1.0 MHz	z)	Vicion V	C _{cb}	N1 - 13	(sbAm 31 =	0.85	pF
Collector-Emitter Capacitance (I _B = 0, V _{CB} = -10 Vdc, f = 1.0 MHz	z)		C _{ce}	M — M	= 30 mAdd) = 80 mAdd)	0.65	
Vdc	-	VBE(set)	MPQ2222			er Skruratio et mAdo, Ig	

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

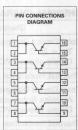
Rating	Symbol	MMPQ2222	MMPQ2222A	Unit
Collector-Emitter Voltage	VCEO	30	40	Vdc
Collector-Base Voltage	VCB	60	75	Vdc
Emitter-Base Voltage	VEB	O*W(5.0 8.f		Vdc
Collector Current — Continuous	IC	500		mAdc

		Each Transistor	Four Transistors Equal Power	
Total Power Dissipation @ T _A = 25°C	PD	0.52	1.0	Watts
Derate above 25°C		4.2	8.0	mW/°C
Total Power Dissipation @ T _C = 25°C	PD	0.8	2.4	Watts
Derate above 25°C		6.4	19.2	mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

MMPQ2222,A*

CASE 751B-05, STYLE 4 SO-16





QUAD GENERAL-PURPOSE TRANSISTORS

NPN SILICON

★MMPQ2222A is a Motorola designated preferred device.

ELECTRICAL	CHARACTERISTICS	(TA	=	25°C unless	otherwise	noted.)

ELECTRICAL CHARACTERISTICS	- ' '	The state of the s		80 TI 2	E LE SERVICIO	SPARKS TAC	107734.1
	teristic	- 1.9m	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	nilla	Jodneyd		pilaneto	med3		
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	e(1)	MMPQ2222 MMPQ2222A	V(BR)CEO	30 40	edov - vola	enti <u>n</u> itaa enti n iimi	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu Adc, I_E = 0$)	-20	MMPQ2222 MMPQ2222A	V(BR)CBO	60 75	(0 = 1) even \(me	j "ab <u>či</u> n 0. l ostas Č osta	Vdc
Emitter-Base Breakdown Voltage (I _B = 10 μAdc, I _C = 0)	0.8-	OEB/BB)V	V(BR)EBO	5.0	= 0) vn Vo lu ge	19 p. <u>Ad</u> dų 1g se B ra uksor	Vdc
Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0) (V _{CB} = 60 Vdc, I _E = 0)		MMPQ2222 MMPQ2222A	ІСВО	Ξ	(0 = - ti -(0 =	50 10	nAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0)			I _{EBO}		(0) = 9	100	nAdc
ON CHARACTERISTICS					8	OFFICIAL TOA	STAHO W
DC Current Gain(1) $(I_C = 100 \ \mu\text{A}, V_{CE} = 10 \ V)$ $(I_C = 1.0 \ \text{mA}, V_{CE} = 10 \ V)$ $(I_C = 10 \ \text{mA}, V_{CE} = 10 \ V)$	08	MMPQ2222A MMPQ2222A MMPQ2222 MMPQ2222A	hFE	35 50 75 75	V 0t —= ac getteV helts km 8 0 — = a	i Gein 5.0 m š do, V imitrar Satu 6.0 mŠdo, 1	-notos lie
(I _C = 150 mA, V _{CE} = 10 V) (I _C = 300 mA, V _{CE} = 10 V) (I _C = 500 mA, V _{CE} = 10 V) (I _C = 150 mA, V _{CF} = 1.0 V)		MMPQ2222 MMPQ2222A MMPQ2222 MMPQ2222A MMPQ2222A		100 100 30 40 50	18 — 10 V CE = 10 V ACTEUS TICK VIUTE Product	300	S-TIAM
Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc)	(1)	MMPQ2222 MMPQ2222A MMPQ2222 MMPQ2222	V _{CE} (sat)		0.7 = 1.0 = 0.7 = 1.0 = 0.7 = 1.0 = 0.7 = 1.0 = 0.7 =	0.4 0.3 1.6 1.0	Vdc
Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc)		MMPQ2222 MMPQ2222A MMPQ2222 MMPQ2222A	V _{BE} (sat)	Ξ	=	1.3 1.2 2.6 2.0	Vdc

FLECTRICAL CHARACTERISTICS (Continued)

Characteristic		Symbol	Min	Тур	Max	Unit
DYNAMIC CHARACTERISTICS						
Current-Gain — Bandwidth Product(1) (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)		fT	200	350	DINTAA, M	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	Unit Unit 3	C _{ob}	0307	4.5	grid <u>eli</u> siloV retrim	pF nepello2
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	pbV 0	C _{ib}	BO V	17	test Ve ltage	pF
SWITCHING CHARACTERISTICS	Strain 20			summing	nO — memul	Collector
Turn-On Time $(V_{CC} = 30 \text{ Vdc}, V_{BE(off)} = -0.5 \text{ Vdc}, I_{C} = 150 \text{ Mg})$	mAdc, I _{B1} = 15 mAdc)	ton	-	25	-	ns
Turn-Off Time $(V_{CC} = 30 \text{ Vdc}, I_C = 150 \text{ mAdc}, I_{B1} = I_{B2} = 150 \text{ mAdc})$	mAdc)	toff	-	250	-	ns
1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle =	2.0%.	3.2	GP 1-	ex - Al si	bave 2690	Dereté o

| Temporaruo Rahue Rahue

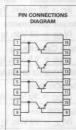
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	15	Vdc
Collector-Base Voltage	VCB	40	Vdc
Emitter-Base Voltage	VEB	4.5	Vdc
Collector Current — Continuous	Ic	500	mAdd

an — 0.85		Each Transistor	Four Transistors Equal Power	igl ob!
Total Power Dissipation @ T _A = 25°C	PD	0.4	0.72	Watts
Derate above 25°C		3.2	6.4	mW/°C
Total Power Dissipation @ T _C = 25°C	PD	0.66	1.92	Watts
Derate above 25°C		5.3	15.4	mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 t	°C	

MMPQ2369*

CASE 751B-05, STYLE 4 SO-16





QUAD SWITCHING TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS		imile			
Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0)	V(BR)CEO	15	+	-	Vdc
Collector-Base Breakdown Voltage (IC = 10 μ Adc, IE = 0)	V _(BR) CBO	40	-	-	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V(BR)EBO	4.5 —	=		Vdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0)	ICBO	-	-	0.4	μAdc
ON CHARACTERISTICS				BINES	
DC Current Gain(1) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 100 mAdc, V _{CE} = 2.0 Vdc)	hFE	40 20	_	=	-
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	V _{CE(sat)}	_	_	0.25	Vdc
Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	V _{BE(sat)}		-	0.9	Vdc
DYNAMIC CHARACTERISTICS	are with the last				
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	fΤ	450	550	-	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	C _{ob}	-	2.5	4.0	pF
Input Capacitance $V_{EB} = 0.5 \text{ Vdc}, I_{C} = 0, f = 1.0 \text{ MHz})$	C _{ib}	-	3.0	5.0	pF
SWITCHING CHARACTERISTICS				ist had a	
Turn-On Time $(V_{CC}=3.0\ Vdc,\ (V_{EB(off)}=1.5\ Vdc,\ I_{C}=10\ mAdc,\ I_{B1}=3.0\ mAdc)$	ton		9.0	-	ns
Turn-Off Time $(V_{CC} = 3.0 \text{ Vdc}, I_C = 10 \text{ mAdc}, I_{B1} = 3.0 \text{ mAdc}, I_{B2} = 1.5 \text{ mAdc})$	toff	-	15	-	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle = 2.0%.

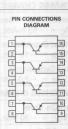
Rating	Symbol	MMPQ2907	MMPQ2907A	Unit
Collector-Emitter Voltage	VCEO	-40	-60	Vdc
Collector-Base Voltage	VCB	_	Vdc	
Emitter-Base Voltage	VEB	di ³ -!	Vdc	
Collector Current — Continuous	Ic	-(mAdd	

30 — 06		Each Transistor	Four Transistors Equal Power	(ptsA
Total Power Dissipation @ T _A = 25°C	PD	0.52	1.0	Watts
Derate above 25°C		4.2	8.0	mW/°C
Total Power Dissipation @ T _C = 25°C	PD	0.8	2.4	Watts
Derate above 25°C		6.4	19.2	mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

MMPQ2907,A*

CASE 751B-05, STYLE 4 S0-16





QUAD GENERAL PURPOSE TRANSISTORS

PNP SILICON

★MMPQ2907A is a Motorola designated preferred device.

Characteristi	c	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) $(I_C = -10 \text{ mAdc}, I_B = 0)$	MMPQ2907 MMPQ2907A	V(BR)CEO	-40 -60	Ξ	_	Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc$, $I_E = 0$)		V(BR)CBO	-60		-	Vdc
Emitter-Base Breakdown Voltage (I _E = -10μ Adc, I _C = 0)		V _{(BR)EBO}	-5.0 -		_	Vdc
Collector Cutoff Current ($V_{CB} = -30$ Vdc, $I_{E} = 0$) ($V_{CB} = -50$ Vdc, $I_{E} = 0$)	MMPQ2907 MMPQ2907A	ICBO	=	=	-50 -10	nAdc
Emitter Cutoff Current (V _{EB} = -3.0 Vdc, I _C = 0)		I _{EBO}	-	-	-50	nAdc
ON CHARACTERISTICS						
DC Current Gain(1) $ \begin{aligned} &(I_C = -100 \ \mu Adc, \ V_{CE} = -10 \ V) \\ &(I_C = -1.0 \ m Adc, \ V_{CE} = -10 \ V) \\ &(I_C = -10 \ m Adc, \ V_{CE} = -10 \ V) \\ &(I_C = -150 \ m Adc, \ V_{CE} = -10 \ V) \\ &(I_C = -300 \ m Adc, \ V_{CE} = -10 \ V) \\ &(I_C = -500 \ m Adc, \ V_{CE} = -10 \ V) \end{aligned} $	MMPQ2907A MMPQ2907A MMPQ2907/2907A MMPQ2907/2907A MMPQ2907/2907A MMPQ2907/2907A	hFE	75 100 75/100 100 30/50 50		300	-
Collector-Emitter Saturation Voltage(1) ($I_C = -150 \text{ mAdc}$, $I_B = -15 \text{ mAdc}$) ($I_C = -300 \text{ mAdc}$, $I_B = -30 \text{ mAdc}$) ($I_C = -500 \text{ mAdc}$, $I_B = -50 \text{ mAdc}$)	MMPQ2907 MMPQ2907 MMPQ2907	VCE(sat)	Ξ	Ē	-0.4 -1.6 -1.6	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = -150 \text{ mAdc}$, $I_B = -15 \text{ mAdc}$) ($I_C = -300 \text{ mAdc}$, $I_B = -30 \text{ mAdc}$) ($I_C = -500 \text{ mAdc}$, $I_B = -50 \text{ mAdc}$)	MMPQ2907 MMPQ2907 MMPQ2907A	VBE(sat)	Ξ	=	-1.3 -2.6 -2.6	Vdc

ELECTRICAL CHARACTERISTICS (Continued)

Characteristic	Symbol	Min	Тур	Max	Unit
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) (I _C = -50 mAdc, V _{CE} = -20 Vdc, f = 100 MHz)	fT voe Corex	200	350	Polytek in	MHz
Output Capacitance (V _{CB} = -10 Vdc, I _E = 0, f = 1.0 MHz)	C _{ob}	Vego	6.0	mistor Voltage	pF
Input Capacitance (VEB = -2.0 Vdc, I _C = 0, f = 1.0 MHz)	C _{ib}	837	20	e pittoV e	pF
SWITCHING CHARACTERISTICS	Maria de la companya della companya		CEONERN	day to retain	N. Honterda
Turn-On Time $(V_{CC} = -30 \text{ Vdc}, I_C = -150 \text{ mAdc}, I_{B1} = -15 \text{ mAdc})$	ton	-	30	-	ns
Turn-Off Time $(V_{CC} = -6.0 \text{ Vdc}, I_{C} = -150 \text{ mAdc}, I_{B1} = I_{B2} = -15 \text{ mAdc})$	toff	a#	100	Dissipation	ns
) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.				1502 9301	5 to 6 to 6

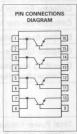
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-40	Vdc
Collector-Base Voltage	VCB	-40	Vdc
Emitter-Base Voltage	VEB	-5.0	Vdc
Collector Current — Continuous	Ic	-1.0	Adc

QUAD RE DRIVER	00	Each Transistor	Four Transistors Equal Power	ded men
Power Dissipation @ T _A = 25°C Derate above 25°C	PD	0.52 4.2	1.2 9.6	Watts mW/°C
Power Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	- 55 t	°C	

MMPQ3467*

CASE 751B-05, STYLE 4 SO-16





QUAD MEMORY DRIVER TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

 $\textbf{ELECTRICAL CHARACTERISTICS} \; (T_{\mbox{\scriptsize A}} = 25^{\circ} \mbox{C unless otherwise noted.})$

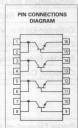
Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS			80	RACTENIEN	AH2 730
Collector-Emitter Breakdown Voltage(1) (I _C = -10 mAdc, I _B = 0)	V(BR)CEO	-40	staV m vebdi - 0)	Emi no i Gre O monde, ig	Vdc
Collector-Base Breakdown Voltage (I _C = -10μ Adc, I _E = 0)	V(BR)CBO	-40	cyvn v ollaga g = 0)	um (-) zs8- MinbAu 90	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc, I_C = 0$)	V(BR)EBO	-5.0 —	egs no v nw	otoxia nd sauc egi a n An 0	Vdc
Collector Cutoff Current (V _{CB} = -30 Vdc, I _E = 0)	ІСВО	_	- in	-200	nAdc
Emitter Cutoff Current (V _{EB} = -3.0 Vdc, I _C = 0)	IEBO	-	- (1)8	-200	nAdc
ON CHARACTERISTICS		HYPT	(shV 9.1 = an	Warrish 20	i all
DC Current Gain(1) ($I_C = -500 \text{ mAdc}$, $V_{CE} = -1.0 \text{ Vdc}$)	hFE	20	g = <u>2</u> 0 vdd ration Voltan	60 m <u>A</u> rto V Emitter Satu	<u>dli;</u> Collector
Collector-Emitter Saturation Voltage(1) (IC = -500 mAdc, IB = -50 mAdc)	VCE(sat)	-	-0.23	-0.5	Vdc
Base-Emitter Saturation Voltage(1) (I _C = -500 mAdc, I _B = -50 mAdc)	V _{BE} (sat)		-0.9	-1.2	Vdc
DYNAMIC CHARACTERISTICS			pubbil ditile	bnuB - rilai	Darrero
Current-Gain — Bandwidth Product (I _C = -50 mAdc, V _{CE} = -10 Vdc, f = 100 MHz)	fT	= 10 <u>0</u> WHz	190	0 m <u>Ad</u> o, Vig	MHz
Output Capacitance (V _{CB} = -10 Vdc, I _E = 0, f = 1.0 MHz)	C _{ob}	(s d)	10	al pay or ecastion	pF
Input Capacitance (VEB = -0.5 Vdc, IC = 0, f = 1.0 MHz)	C _{ib}	_(1)+0	55	diri <u>n</u> 8.0 Darkho sh	pF
SWITCHING CHARACTERISTICS				900	no-muT
Turn-On Time (I _C = -500 mAdc, I _{B1} = -50 mAdc)	ton	Yelzem =	20	gl. al. <u>A</u> m 00 Tiores	ns
Turn-Off Time (I _C = -500 mAdc , I _{B1} = I _{B2} = -50 mAdc)	^t off	TopAm Mg = eby5	60	ativa equa : 1	ns

Rating	Symbol	Va	Unit	
Collector-Emitter Voltage	VCEO	MinQ.	40	Vdc
Collector-Emitter Voltage	VCES	aby T	60	Vdc
Emitter-Base Voltage	VEB	sev !	5.0	Vdc
Collector Current — Continuous	lc	ata V	Adc	
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C	
GAUD		Each Transistor	Four Transistors Equal Power	doc3
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PD	0.6 4.8	1.4	Watts mW/°C
Power Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0 8.0	2.5 2.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 1	°C	

MMPQ3725*

CASE 751B-05, STYLE 4 SO-16





QUAD CORE DRIVER TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS			- 85	RACTERISTS	AHO THO
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0)	V(BR)CEO	40	ildov <u>a</u> voliti j = Bj.	Emil <u>s</u> tima FabAci 07-	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, V _{BE} = 0)	V(BR)CES	60	own <u>Vo</u> ltaga = 0)	19 1. Add. 1g	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0)	V(BR)EBO	5.0	wn V <u>oll</u> age = 0)	208 <u>Br</u> ukde 10 #Add, Ig	Vdc
Collector Cutoff Current (V _{CB} = 40 Vdc, I _E = 0)	ICBO	_	(0 = 3	0.5	μAdo
ON CHARACTERISTICS(1)				memod lienu	O istilini
DC Current Gain (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 2.0 Vdc)	hFE	35 25	75 45	200	EANO MO
Collector-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc)	VCE(sat)	(tabl)	0.32	0.45	Vdc
Base-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc)	VBE(sat)	0.8	0.9	1.1 Letter at	Vdc
DYNAMIC CHARACTERISTICS		(altu	Am Di - e	-500 mAdd,	- 201
Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	fT	-	275	oHABACTI ein — Bind	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	Cob	1 cor <u>1</u> 1 cor	5.1	egns/bacq	pF
Input Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	C _{ib}	<u>C</u> HW.	62	LobV_D1 =	pF
SWITCHING CHARACTERISTICS		Q MHIZ)	T = 1.0 = 5	-,LLS Vida, 1	- gaVI
Turn-On Time ($I_C = 500 \text{ mAdc}$, $I_{B1} = 50 \text{ mAdc}$, $V_{BE(off)} = -3.8 \text{ Vdc}$)	ton	_	20	DARALO DI	ns
Turn-Off Time (I _C = 500 mAdc, I _{B1} = I _{B2} = 50 mAdc)	toff	_(a)A	50	SDU_mAde,	ns

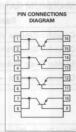
Rating	Symbol		Value		Unit
Collector-Emitter Voltage	VCEO	obV	-60	- 66	Vdc
Collector-Base Voltage	VCB		-60	08	Vdc
Emitter-Base Voltage	VEB	- obV	-5.0		Vdc
Collector Current — Continuous	Ic	ohAm	-200	200	mAdo

dau	0	Each Transistor	Four Transistors Equal Power	doub doubles	
Power Dissipation @ T _A = 25°C Derate above 25°C	PD	0.4 3.2	0.72 6.4	Watts mW/°C	
Power Dissipation @ T _C = 25°C Derate above 25°C	PD PD	0.66 5.3	1.92 15.4	Watts mW/°C	
Operating and Storage Junction Temperature Range	T _J , T _{stg}	○ −55 t	°C		

MMPQ3799*

CASE 751B-05, STYLE 4 SO-16





QUAD AMPLIFIER TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS				8:	STERRITORS	AHD THE
Collector-Emitter Breakdown Voltage(2) (I _C = -10 mAdc, I _B = 0)	V(BR)CEO	V(BR)CEO	-60	stloV m vobl	Enviren Breit	Vdc
Collector-Base Breakdown Voltage (I _C = -10 μAdc, I _E = 0)	оваже!У	V(BR)CBO	-60	égallov nivo	hitaon a s asé 6 a Ada, la s	Vdc
Emitter-Base Breakdown Voltage (I _E = -10 μAdc, I _C = 0)	OBSIRBIV	V(BR)EBO	-5.0	ада то М гий (0	ese Sra akdor 9 aAdor) e a	Vdc
Collector Cutoff Current (V _{CB} = -50 Vdc, I _E = 0)	080	ІСВО		- m	-10	nAdd
Emitter Cutoff Current (V _{EB} = -3.0 Vdc, I _C = 0)	oas .	IEBO	-	(0 =	-20	nAdd
ON CHARACTERISTICS(2)				S(1)	on adutom	TARIO INT
DC Current Gain		hFE	225 300 300 250	(abV = = 9 (abV = 1 = 9	nt Gain 11 mArto, Vo 10 mArto, Vo 10 mArto, Vo	00 - 00 00 = 0 00 = 0 00 = 0
Collector-Emitter Saturation Voltage ($I_C = -100 \mu Adc$, $I_B = -10 \mu Adc$) ($I_C = -1.0 \mu Adc$, $I_B = -100 \mu Adc$)	(See See V	VCE(sat)	=	-0.12 -0.07	-0.2 -0.25	Vdc
Base-Emitter Saturation Voltage ($I_C = -100 \mu Adc$, $I_B = -10 \mu Adc$) ($I_C = -1.0 \mu Adc$, $I_B = -100 \mu Adc$)		VBE(sat)	-	-0.62 -0.68	-0.7 -0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS			454M 001 =	= 20 Vdc, f	JOY JONAIN D	1 = 50
Current-Gain — Bandwidth Product ($I_C = -1.0 \text{ mAdc}$, $V_{CE} = -5.0 \text{ Vdc}$, $f = 1$	00 MHz)	fT	60	250	gLobV 0.6	MHz
Output Capacitance $(V_{CB} = -5.0 \text{ Vdc}, I_E = 0, f = 100 \text{ kHz})$	100	C _{obo}	(z/st)	2.1	4.0	pF
Input Capacitance (VEB = -0.5 Vdc, IC = 0, f = 100 kHz)	nol	C _{ibo}	_	5.5	8.0	pF
Noise Figure (I _C = -100μ Adc, V _{CE} = $-10 V$ dc, R _S = f = 1.0 kHz)	3.0 kohms,	NF	Total of	1.5	jasjv <u>s</u> av u jemil rel obAm d	dB

⁽²⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

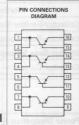
Rating	Symbol	Value		Unit
Collector-Emitter Voltage	VCEO	40	pa-	Vdc
Collector-Base Voltage	V _{CB}	60	00 -	Vdc
Emitter-Base Voltage	VEB	6.0	0.8-	Vdc
Collector Current — Continuous	lc	200	- 200	mAdd

		Each Transistor	Four Transistors Equal Power	stoud stelanos
Total Power Dissipation @ T _A = 25°C	PD	0.4	0.72	Watts
Derate above 25°C		3.2	6.4	mW/°C
Total Power Dissipation @ T _C = 25°C	PD	0.66	1.92	Watts
Derate above 25°C		5.3	15.4	mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150		°C

MMPQ3904*

CASE 751B-05, STYLE 4 SO-16





QUAD AMPLIFIER/SWITCH TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Characterist	ic ladmys	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS				20	I SHETOM	AND MO
Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0)	O33(F(S))	V _(BR) CEO	40	utlov <u>m</u> webi (0 = g	Emilitar Bia 10-mAda 1	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _E = 0)	- ABBRERO	V _(BR) CBO	60	egast <u>ov</u> nevo = 0)	itaas <u>B</u> resks 10 µAdb. is	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	Y(BR)ERO -	V _{(BR)EBO}	6.0	oge <u>tlo</u> V mer (0 =	sse B <u>r</u> sakuto 10 <u>sA</u> daş lo	Vdc
Collector Cutoff Current (VCB = 40 Vdc, I _E = 0)	Gap	ICBO	-	10 = 3	50	nAdd
Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0)	Casi	IEBO	-	10 = 5	50	nAdc
ON CHARACTERISTICS(1)				18/81	N FOLLSTON	HAVED INC
DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc)		hFE	30 50 75	90 160 200	10 <u>u A</u> da, v 100 <u>u A</u> da, v 100 <u>u A</u> da,	(Ic = :
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	Voteses	V _{CE(sat)}		0.1	0.2	Vdc
Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)		V _{BE(sat)}	tob	0.65	0.85	Vdc
DYNAMIC CHARACTERISTICS	(169/36)		To the	ndu file = nl	Ships ont	oll
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100	MHz)	fT	250	300	J. 6 mAde	MHz
Output Capacitance ($V_{CB} = 5.0 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	70	C _{ob}	DOT = 1 and	2.0	4.0	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	- coso	C _{ib}	Trains o	4.0	8.0	pF
SWITCHING CHARACTERISTICS					stores Hora	va D. tuenin
Turn-On Time (I _C = 10 Vdc, $V_{BE(off)} = -0.5$ Vdc, I_{B1}	= 1.0 mAdc)	ton	44HJ 0	37	,56V=0-	ns
Turn-Off Time (I _C = 10 mAdc, I _{B1} = I _{B2} = 1.0 mAdc)		toff	is. Pip = Si	136	100 ±4dc, idła)	ns

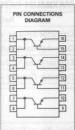
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Rating	Symbol	V	Unit	
Collector-Emitter Voltage	VCEO	-40		Vdc
Collector-Base Voltage	VCB	-	-40	Vdc
Emitter-Base Voltage	VEB	-	5.0	Vdc
Collector Current — Continuous	Ic	-200		mAdc
		Each Transistor	Four Transistors Equal Power	Asad ozulens
Power Dissipation @ T _A = 25°C Derate above 25°C	PD	0.4 3.2	0.72 6.4	Watts mW/°C
Power Dissipation @ T _C = 25°C Derate above 25°C	PD	0.66 5.3	1.92 15.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

MMPQ3906*

CASE 751B-05, STYLE 4 SO-16





QUAD AMPLIFIER/SWITCH TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS		Line La mail			
Collector-Emitter Breakdown Voltage(1) (I _C = -1.0 mAdc, I _B = 0)	V(BR)CEO	-40 (1)a	a	earts root or	Vdc
Collector-Base Breakdown Voltage (I _C = -10 μAdc, I _E = 0)	V(BR)CBO	-40	egelleV rivid	balend or s	Vdc
Emitter-Base Breakdown Voltage (I _E = -10μ Adc, I _C = 0)	V(BR)EBO	-5.0	eguitoV ny	iso Breekder	Vdc
Collector Cutoff Current (V _{CB} = -30 Vdc, I _E = 0)	Ісво	-	(0	-50	nAdc
Emitter Cutoff Current (VEB = -4.0 Vdc, IC = 0)	IEBO	-	(0 -	-50	nAdc
ON CHARACTERISTICS(1)			19 -	31.3hV 0.8	= 83V/
DC Current Gain ($I_C = -0.1$ mAdc, $V_{CE} = -1.0$ Vdc) ($I_C = -1.0$ mAdc, $V_{CE} = -1.0$ Vdc) ($I_C = -10$ mAdc, $V_{CE} = -1.0$ Vdc)	hFE	40 60 75	160 180 200	Westerna Head A ON SHORT ON SHORT	EARLO 200 (c) = 00 (c) = 01
Collector-Emitter Saturation Voltage (I _C = -10 mAdc, I _B = -1.0 mAdc)	VCE(sat)	-	-0.1	-0.25	Vdc
Base-Emitter Saturation Voltage (I _C = -10 mAdc, I _B = -1.0 mAdc)	V _{BE(sat)}	-	-0.65	-0.85	Vdc
DYNAMIC CHARACTERISTICS			(obAm 0.1	gl ,abAnr t	it = all
Current-Gain — Bandwidth Product (I _C = -10 mAdc, V _{CE} = -20 Vdc, f = 100 MHz)	fT	200	250	araa <u>k</u> ada anar— air	MHz
Output Capacitance (V _{CB} = -5.0 Vdc, I _E = 0, f = 1.0 MHz)	C _{ob}	HW CH =	3.3	4.5	pF
Input Capacitance (VEB = -0.5 Vdc, I _C = 0, f = 1.0 MHz)	C _{ib}	(XFE	4.8	10	pF
SWITCHING CHARACTERISTICS	91/2	9 (sHa	10,5 = 1,0 =	31 36V 2.0	一四分
Turn-On Time $(I_C = -10 \text{ mAdc}, V_{BE(off)} = 0.5 \text{ Vdc}, I_{B1} = -1.0 \text{ mAdc})$	ton	20.5 × stay0	43	robitiv seturs :	ns
Turn-Off Time (I _C = -10 mAdc, I _{B1} = I _{B2} = -1.0 mAdc)	toff	-	155	-	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

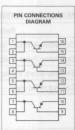
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	VCB	40	Vdc
Emitter-Base Voltage	VEB	5.0	Vdc
Collector Current — Continuous	Ic	200	mAdd

OUAG BANG	FRATA	Each Transistor	Four Transistors Equal Power	rios (3 ozelena
Total Power Dissipation @ T _A = 25°C	PD	0.4	0.72	Watts
Derate above 25°C		3.2	6.4	mW/°C
Total Power Dissipation @ T _C = 25°C	PD	0.66	1.92	Watts
Derate above 25°C		5.3	15.4	mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	- 55 t	to +150	°C

MMPQ6700*

CASE 751B-05, STYLE 4 SO-16





QUAD **COMPLEMENTARY PAIR** TRANSISTOR

PNP(2)/NPN SILICON

★This is a Motorola designated preferred device.

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	The state of the s	anutick con-	the less to the sales	Lachella
Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0)	V(BR)CEO	40	t.0 or ← is, ig	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _E = 0)	V(BR)CBO	40	Fig. (Parks) of	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	V(BR)EBO	5.0	Course Course	Vdc
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0)	ІСВО	- (0	50	nAdc
Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0)	IEBO	- (0 :	50	nAdc
ON CHARACTERISTICS(1)			man s	C Current
DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc)	hFE (a)	30 50 70	I.1 mAde, V _C I.0 mAde, V _C I0 mA=s, V _C	- = Ol) - = Ol) - = -
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	VCE(sat)	oAm <u>Alf</u> -	0.25	Vdc
Base-Emitter Saturation Voltage (IC = 10 mAdc, I _B = 1.0 mAdc)	V _{BE} (sat)	- TA mAct	0.9	Vdc
DYNAMIC CHARACTERISTICS			Dischursi pla	C memu
Current-Gain — Bandwidth Product(1) (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	MM OfT = Y	200	10 m246. VOE	MHz
Output Capacitance ($V_{CB} = 5.0 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C _{ob}	0,1 = 1,0	4.5	pF
Input Capacitance $(V_{EB}=0.5\ Vdc,\ I_{C}=0,\ f=1.0\ MHz)$ PNP NPN	C _{ib}	0.1 = 1.0 801188	10 8.0	pF

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (2) Voltage and Current are negative for PNP Transistors.

MMPQ6842

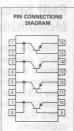
CASE 751B-05, STYLE 4 SO-16

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	30	Vdc
Collector-Base Voltage	V _{CB}	30	Vdc
Emitter-Base Voltage	VEB	4.0	Vdc
Collector Current — Continuous	Ic	200	mAdo

		Each Transistor	Four Transistors Equal Power	e ami n d space or law
Total Power Dissipation @ T _A = 25°C	PD	0.4	0.72	Watts
Derate above 25°C		3.2	6.4	mW/°C
Total Power Dissipation @ T _C = 25°C	PD	0.66	1.92	Watts
Derate above 25°C		5.3	15.4	mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 1	to +150	°C





QUAD MPU CLOCK BUFFER **TRANSISTOR**

PNP(2)/NPN SILICON

Characteri	stic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	CHICA .	THE TIME DOUGHT		O OF TOURISM	BOINER DEVICE	eatl eatl
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0)	FERTALIS (OUCLOSES)	V(BR)CEO	30	mit reel.	odo. u r visa	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _E = 0)	Symbol	V(BR)CBO	30	-		Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	VCSO	V _{(BR)EBO}	4.0	_ ogs egstic	tor-E <u>ns</u> e Val	Vdc
Collector Cutoff Current (VCB = 20 Vdc, IE = 0)	o ⁱ	ІСВО	_	_	50	nAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0)	04	I _{EBO}	(1)0.9	Or A V S VOIS	50	nAdc
ON CHARACTERISTICS(1)			85	ACTERISTIC	RAHD JAN	пант
DC Current Gain (I _C = 0.5 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc)	Symbol AUAR	hFE balnuom eosh	30 50 70	-nolta <u>cut</u> , — s	nal Rask tand	medT
Collector-Emitter Saturation Voltage (I _C = 0.5 mAdc, I _B = 0.05 mAdc, 0° C \leq T \leq 70°C)		V _{CE} (sat)	ing Purposes.	0.05	0.15	Vdc
Base-Emitter Saturation Voltage (I _C = 0.5 mAdc, I _B = 0.05 mAdc)		V _{BE(sat)}	LIAV ROTE	0.65	0.9	Vdc
DYNAMIC CHARACTERISTICS	DI TRI	Rarfeln g			entrett	
Current-Gain — Bandwidth Product(1) (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 10	00 MHz)	f _{TA8A}	200	350	TUTTER PT JOHN COM	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	70- 01-	C _{ob}	-	3.0	4.5	pF
Input Capacitance $(V_{EB} = 0.5 \text{ Vdc}, I_{C} = 0, f = 1.0 \text{ MHz})$	PNP NPN	Cib		5.0 4.0	10 8.0	pF
SWITCHING CHARACTERISTICS (TA =	25°C, V _{CC} = 5.0 Vdc)	Laa			(S) TILES IS IN	UNIM L
Propagation Delay Time (50% Points TP1 to TP3) (50% Points TP2 to TP4)		tPLH tPHL	_	15 6.0	25 15	ns
Rise Time (0.3 V to 4.7 V, TP3 or TP4)		se a shirt t _r super	5.0	25	35	ns
Fall Time (4.7 V to 0.3 V, TP3 or TP4)		tf	5.0	10	20	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s Duty Cycle \leq 2.0%. (2) Voltage and Current are negative for PNP Transistors.

Bias Resistor Transistor

PNP Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base-emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SOT-23 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- The SOT-23 package can be soldered using wave or reflow.
 The modified gull-winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
 Use the Device Number to order the 7 inch/3000 unit reel.
 Replace "T1" with "T3" in the Device Number to order the
 13 inch/10,000 unit reel.

PIN3
COLLECTOR
(OUTPUT)

PIN1
BASE
(INPUT)

PIN2
EMITTER
(GROUND)



MMUN2111LT1 SERIES

Motorola Preferred Devices

PNP SILICON

BIAS RESISTOR

TRANSISTOR

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V _{CBO}	50	Vdc
Collector-Emitter Voltage	VCEO	50	Vdc
Collector Current	Ic	100	mAdc
Total Power Dissipation @ T _A = 25°C(1) Derate above 25°C	PD	200 1.6	mW mW/°C

THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Resistance — Junction-to-Ambient (surface mounted)	R _θ JA	625	°C/W
Operating and Storage Temperature Range	TJ, T _{stg}	-65 to +150	°C
Maximum Temperature for Soldering Purposes, Time in Solder Bath	(OTE > T >	260 10	°C Sec

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	R2 (K)
MMUN2111LT1	A6A	10	10
MMUN2112LT1	A6B	22 (\$400 001 = 3)	22
MMUN2113LT1	A6C	47	47
MMUN2114LT1	A6D	10 (5HN 0.1	= 1.0 = 47.02 0.3 = 95
MMUN2115LT1(2)	A6E	10	00
MMUN2116LT1(2)	A6F	4.7	= 1.0 = 0 0 by a 0 = 93
MMUN2130LT1(2)	A6G	1.0	1.0
MMUN2131LT1(2)	A6H	2.2	2.2
MMUN2132LT1(2)	A6J	4.7	4.7
MMUN2133LT1(2)	A6K	4.7	47
MMUN2134LT1(2)	A6L	22	47

- 1. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.
- 2. New devices. Updated curves to follow in subsequent data sheets.

Preferred devices are Motorola recommended choices for future use and best overall value.

(Replaces MMUN2111T1/D)

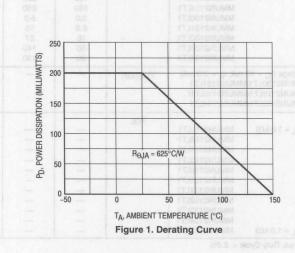
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	nIM today	Symbol	Min	Тур	Max	Unit
FF CHARACTERISTICS	VOH 1.9	GIN O.	1 = JA N 8.0	= 8.0 V, Vg =	agV) (lb) so	atley tugget
Collector-Base Cutoff Current (V _{CB} = 50 V,	E = 0)	СВО	righans (5)	N. D. I. S. J. IV.	100	nAdc
Collector-Emitter Cutoff Current (V _{CE} = 50	V, I _B = 0)	ICEO	ILIMI A	_	500	nAdc
Emitter-Base Cutoff Current	MMUN2111LT1	IEBO	ALISSOUT ACTOR	0 V, Fig = 1:0	0.5	mAdc
$(V_{EB} = 6.0 \text{ V}, I_{C} = 0)$	MMUN2112LT1	-9.400013	IPAREIN ATTEN	nu = Turin o	0.2	Y = 30 Y
Gal Et Or	MMUN2113LT1	17.11199	NORDA-		0.1	reiseA tugi
	MMUN2114LT1	PTJSHS	SUNU +	_	0.2	306
	MMUN2115LT1	ITIERS	Multill ä-	-	0.9	
	MMUN2116LT1	TEATS	KUMH a-	_	1.9	
	MMUN2130LT1	1708/19	NUMB -	-	4.3	
	MMUN2131LT1	TEMPTS	KUMI)	_	2.3	1 - 110
	MMUN2132LT1	1TJ08(S)	NUMB -	_	1.5	7 1911
	MMUN2133LT1	PTUTETS	othun a -	_	0.18	1 50
1.8 (.4	MMUN2134LT1	PTUSINE	MURVIN	-	0.13	
Collector-Base Breakdown Voltage ($I_C = 10 \mu A$, $I_E = 0$)		V(BR)CBO	50	_	- 1	Vdc
Collector-Emitter Breakdown Voltage(3) (I _C = 2.0 mA, I _B = 0)		V(BR)CEO	50	SHUMBUTT	TS/ILIVVI o	Vdc
ON CHARACTERISTICS(3)						
DC Current Gain	MMUN2111LT1	hFE	35	60	Newson Tests	
(V _{CE} = 10 V, I _C = 5.0 mA)	MMUN2112LT1	1 6 201 30	60	100	ELECTRICAL TOTAL	
	MMUN2113LT1		80	140	AL SATISTICAL	
	MMUN2114LT1		80	140	_	
	MMUN2115LT1		160	250	_	
	MMUN2116LT1		160	250	_	
	MMUN2130LT1		3.0	5.0	-	1 - 1
	MMUN2131LT1		8.0	15	-	1000
	MMUN2132LT1		15	27	_	
	MMUN2133LT1		80	140	-	
	MMUN2134LT1		80	130		
$ \begin{array}{ll} \mbox{Collector-Emitter Saturation Voltage (I_C = 1 \\ \mbox{(I_C = 10 mA, I_B = 5 mA)} & \mbox{MMUN2130LT1} \\ \mbox{(I_C = 10 mA, I_B = 1 mA)} & \mbox{MMUN2115LT1} \\ \mbox{MMUN2132LT1/MMUN2133LT1} \end{array} $	/MMUN2131LT1 /MMUN2116LT1/	VCE(sat)		ON GRUTTANN	0.25	Vdc
Output Voltage (on)		V _{OL}		189	PER IS	Vdc
$(V_{CC} = 5.0 \text{ V}, V_B = 2.5 \text{ V}, R_L = 1.0 \text{ k}\Omega)$	MMUN2111LT1			<u> </u>	0.2	
	MMUN2112LT1		- 1	3-	0.2	
	MMUN2114LT1	Rota - 825		8-	0.2	
	MMUN2115LT1	770	- 0	9-	0.2	
	MMUN2116LT1		-	9	0.2	
	MMUN2130LT1		-	-	0.2	
	MMUN2131LT1			_	0.2	
	MMUN2132LT1	9	- 00-	_	0.2	
	MMUN2133LT1	TILL AMBIENT TIE	_	_	0.2	
(Va- E0V V- 0EV D. 1010)	MMUN2134LT1	intil a solution	_	_	0.2	
$(V_{CC} = 5.0 \text{ V}, V_B = 3.5 \text{ V}, R_L = 1.0 \text{ k}\Omega)$	MMUN2113LT1	Figure 1. Du		_	0.2	

^{3.} Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS Continued (TA = 25°C unless otherwise noted) AD ADDITIONAL AND ADDITI

no0	C	haracteristic	all lodge a	Symbol	Min	Тур	Max	Unit
Output Voltage	(off) (VCC	= 5.0 V, V _B = 0.5 V	$/$, $R_L = 1.0 \text{ k}\Omega$)	VOH	4.9	_	601 12 (F6T)	Vdc
$(V_{CC} = 5.0)$	$V, V_B = 0.2$	$25 \text{ V}, \text{RL} = 1.0 \text{ k}\Omega)$	MMUN2115LT1 MMUN2116LT1		(0 = g) .V	de = goV) tot	se Cutoff Curr	Collector-Be
			MMUN2131LT1		10 mg/,V 00	= 30V) fasti	ine Outell Cu	Collector-Err
(V _{CC} = 5.0)	V, V _B = 0.0	050 V, R _L = 1.0 kΩ)	MMUN2132LT1 MMUN2130LT1		MALIN	1	Cutoff Curren	ex6 reilim3 A = paV)
Input Resistor	1.0	-	MMUN2111LT1	R1 LIST	7.0	10	13	kΩ
			MMUN2112LT1		15.4	22	28.6	
			MMUN2113LT1		32.9	47	61.1	
			MMUN2114LT1		7.0	10	13	
			MMUN2115LT1		7.0	10	13	- 4000
			MMUN2116LT1		3.3	4.7	6.1	
			MMUN2130LT1		0.7	1.0	1.3	13-33
			MMUN2131LT1		1.5	2.2	2.9	
			MMUN2132LT1		3.3	4.7	6.1	
			MMUN2133LT1		3.3	4.7	6.1	Eff-rolatio
			MMUN2134LT1		15.4	22	28.6	parter and
Resistor Ratio	MMUN21	11LT1/MMUN2112LT	Γ1/MMUN2113LT1	R ₁ /R ₂	0.8	1.0	1.2	ICI-RORURIUM
	MMUN21	14LT1			0.17	0.21	0.25	DARAHO H
MMUN2		15LT1/MMUN2116LT	Γ1		es to all a	_		
	MMUN21	30LT1/MMUN2131L	T1/MMUN2132LT1		0.8	1.0	1.2	DO Current
	MMUN21	33LT1	96		0.055	0.1	0.185	1 = 30/0



TYPICAL ELECTRICAL CHARACTERISTICS — MMUN2111LT1

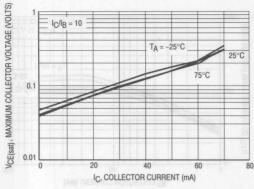


Figure 2. VCE(sat) versus IC

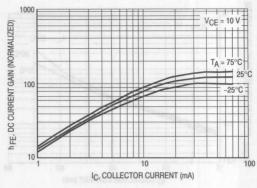


Figure 3. DC Current Gain

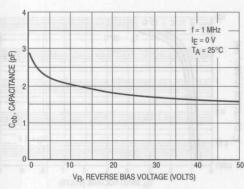


Figure 4. Output Capacitance

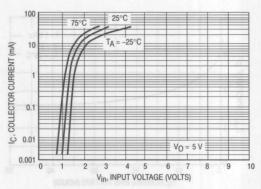


Figure 5. Output Current versus Input Voltage

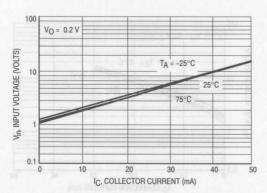
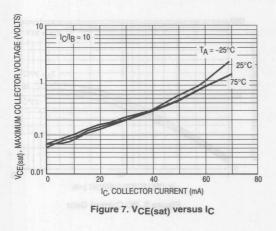


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MMUN2112LT1



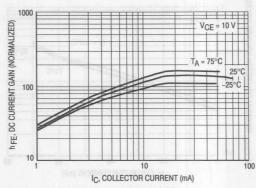


Figure 8. DC Current Gain

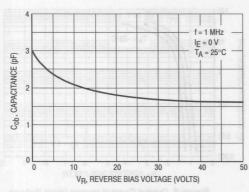


Figure 9. Output Capacitance

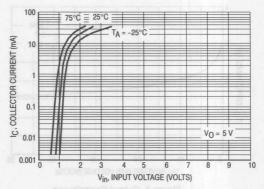


Figure 10. Output Current versus Input Voltage

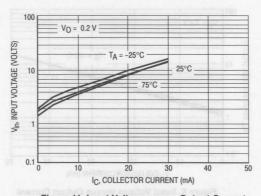


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MMUN2113LT1

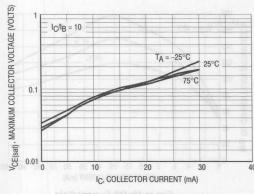


Figure 12. VCE(sat) versus IC

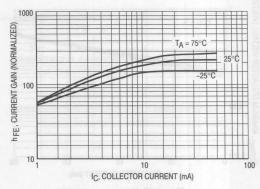


Figure 13. DC Current Gain

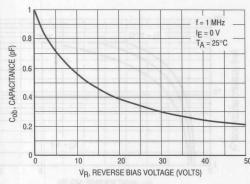


Figure 14. Output Capacitance

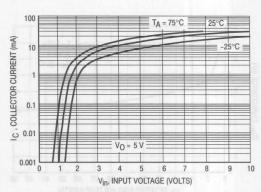


Figure 15. Output Current versus Input Voltage

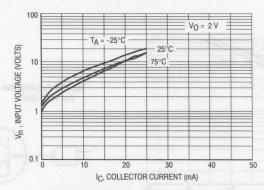


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MMUN2114LT1

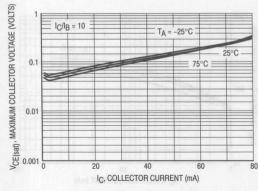


Figure 17. VCE(sat) versus IC

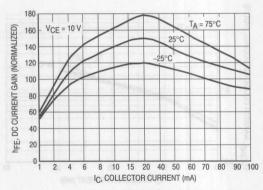


Figure 18. DC Current Gain

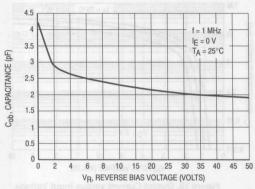


Figure 19. Output Capacitance

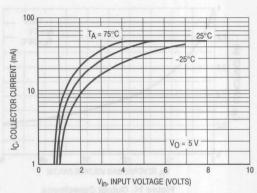


Figure 20. Output Current versus Input Voltage

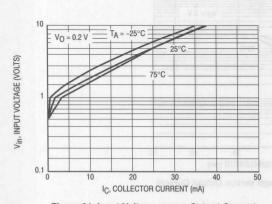


Figure 21. Input Voltage versus Output Current

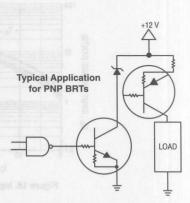


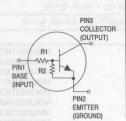
Figure 22. Inexpensive, Unregulated Current Source

Bias Resistor Transistor

NPN Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base-emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SOT-23 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- The SOT-23 package can be soldered using wave or reflow.
 The modified gull-winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
 Use the Device Number to order the 7 inch/3000 unit reel.
 Replace "T1" with "T3" in the Device Number to order the
 13 inch/10.000 unit reel.





MMUN2211LT1

SERIES

Motorola Preferred Devices

NPN SILICON BIAS RESISTOR

TRANSISTOR

CASE 318-07, STYLE 6 SOT-23 (TO-236AB)

MAXIMUM RATINGS (TA = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	VCBO	50	Vdc
Collector-Emitter Voltage	VCEO	50	Vdc
Collector Current	I BELOW IC ACTUR	100	mAdc
Total Power Dissipation @ T _A = 25°C(1) Derate above 25°C	PD	200 1.6	mW mW/°C

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)	R ₀ JA	625	°C/W
Operating and Storage Temperature Range	T _J , T _{stg}	-65 to +150	°C
Maximum Temperature for Soldering Purposes, Time in Solder Bath	SAL MAN TL	260 10	°C Sec

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	R2 (K)
MMUN2211LT1	A8A	10	10
MMUN2212LT1	A8B	22	22
MMUN2213LT1	A8C	47	47
MMUN2214LT1	A8D	10	47
MMUN2215LT1(2)	A8E	10	00
MMUN2216LT1(2)	A8F	4.7	00
MMUN2230LT1(2)	A8G	1	1
MMUN2231LT1(2)	A8H	2.2	2.2
MMUN2232LT1(2)	A8J	4.7	4.7
MMUN2233LT1(2)	A8K	4.7	47
MMUN2234LT1(2)	A8L	22	47

- 1. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.
- 2. New devices. Updated curves to follow in subsequent data sheets.

Preferred devices are Motorola recommended choices for future use and best overall value.

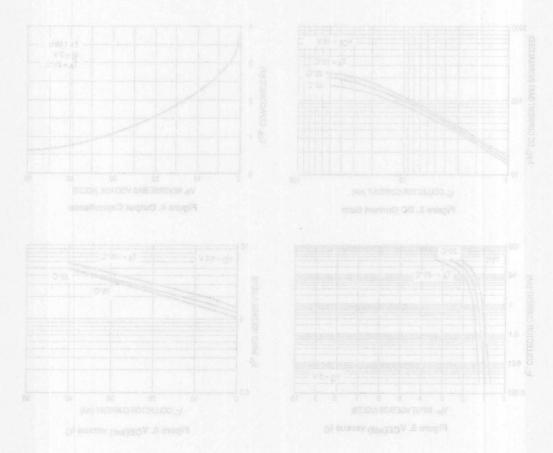
(Replaces MMUN2211T1/D)

Char	acteristic	Symbol	Min	Тур	Max	Unit
FF CHARACTERISTICS					D	
Collector-Base Cutoff Current (Vo	CB = 50 V, IE = 0)	ІСВО	A DAME IN E		100	nAdc
Collector-Emitter Cutoff Current (V _{CE} = 50 V, I _B = 0)	ICEO	MCTIC	SOFILE	500	nAdc
Emitter-Base Cutoff Current	MMUN2211LT1	IEBO	M FOR	188 <u>5</u> 181	0.5	mAdc
$(V_{FB} = 6.0 \text{ V}, I_{C} = 0)$	MMUN2212LT1		_	_	0.2	
. 25	MMUN2213LT1	ganed to repla	sb # mot	tersulistig	0.1	yan air
	MMUN2214LT1	F ssis) THE	edit—tros	ten apid to	0.2	its ext
	MMUN2215LT1	hovitan auto o	idill o- bor	istor - vitts a	0.9	s ediate
	MMUN2216LT1	toleiusi usti s	na-e st ud a l	rie V ot sigen	1.9	s motal
	MMUN2230LT1	nie s sini me	thousand	ni vot zinen	4.3	wihmi ee
	MMUN2231LT1	T enough his	of the same	malaye di	2.3	TEIR E
	MMUN2232LT1	was wall will be	outpup has	Application and	1.5	102 64
	MMUN2233LT1	and and man	STAR TOOLS	HORING OF	0.18	and and
	MMUN2234LT1		_	_	0.13	a seed to see the
Collector-Base Breakdown Voltag		V(BR)CBO	50	_ Highe	ing myshora	Vdc
Collector-Emitter Breakdown Volt	$age^{(3)} (I_C = 2.0 \text{ mA}, I_B = 0)$	V(BR)CEO	50	downs Or the	anama a	Vdc
N CHARACTERISTICS(3)	(6,753.6)	San on award or	ing bigginin	or all aco o	Sestorie PC	OR art
DC Current Gain	MMUN2211LT1	hFE	35	60	willian hailt	The con
(V _{CE} = 10 V, I _C = 5.0 mA)	MMUN2212LT1	oth out of one	60	100	relative to the later	ninablas
	MMUN2213LT1	Mary All of the subject	80	140	- Inchies Inchies	
	MMUN2214LT1		80	140	n min 3 th 8	DENE NEW TOTAL
	MMUN2215LT1	at Jina 000Evr	160	350	DEVICE NUM	erit eal.
	MMUN2216LT1	of tempo of tel	160	350	(0)(2- 17"	Hosique I
	MMUN2230LT1		3.0	5.0	Millio 8-10.0	don Si
	MMUN2231LT1	(buten eaty	8.0	15 AT	SENTAR	MURHING
	MMUN2232LT1		15	30		
	MMUN2233LT1 MMUN2234LT1		80	200	_	
60 Vdc			80	150	igsilov ess	Collegion
Collector-Emitter Saturation Volta (I _C = 10 mA, I _B = 5 mA) MMU (I _C = 10 mA, I _B = 1 mA) MMU MMUN2232LT1/MMU	N2230LT1/MMUN2231LT1	VCE(sat)	_		0.25	Vdc
Output Voltage (on)		VOL	11/2	ACS PAT ST	By 3C w/ort	Vdc
(VCC = 5.0 V, VB = 2.5 V, RL =	= 1.0 kΩ) MMUN2211LT1	, OL	_		0.2	Vac
(OO 512 1, 1B 213 1, 11E	MMUN2212LT1	111111		BOTTERE	0.2	ARANISH
	MMUN2214LT1	betrupm tow	uis) i m idro	lor-ne-mail	0.2	(herman)
	MMUN2215LT1		-	_	0.2	
	MMUN2216LT1		- Ennere	nual garret	0.2	ENTER STATE
	MMUN2230LT1		Purases.	for S ol dering	0.2	rumbest
	MMUN2231LT1		_	-	0.2	Oran in So
	MMUN2232LT1		10.00		0.2	
	MMUN2233LT1	- 23	OTLATIO.	LIBER ON	0.2	NI HOINE
(V _{CC} = 5.0 V, V _B = 3.5 V, R _I =	MMUN2234LT1 = 1.0 kΩ) MMUN2213LT1	grides			0.2	
		N.	-		0.2	1
Output Voltage (off) (V _{CC} = 5.0 V (V _{CC} = 5.0 V, V _B = 0.050 V, F (V _{CC} = 5.0 V, V _B = 0.25 V, R _L	$R_L = 1.0 \text{ k}\Omega$) MMUN2230LT1	VOH	4.9		UNEZIEUTS UNEZIELTS UNEZERALTS UNEZERALTS	Vdc

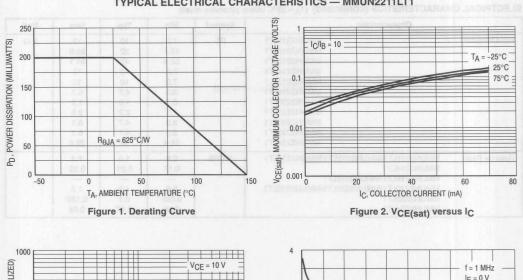
^{3.} Pulse Test: Pulse Width < 300 μ s, Duty Cycle < 2.0%.

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted)

	Characteristic	Symbol	Min	Тур	Max	Unit
Input Resistor	MMUN2211LT1	R1	7.0	10	13	kΩ
	MMUN2212LT1		15.4	22	28.6	
	MMUN2213LT1		32.9	47	61.1	100
	MMUN2214LT1	-	7.0	10	13	
	MMUN2215LT1		7.0	10	13	200
	MMUN2216LT1		3.3	4.7	6.1	De
	MMUN2230LT1		0.7	1.0	1.3	
	MMUN2231LT1		1.5	2.2	2.9	100
	MMUN2232LT1		3.3	4.7	6.1	100
	MMUN2233LT1	1	3.3	4.7	6.1	
	MMUN2234LT1		15.4	22	28.6	Që
Resistor Ratio	MMUN2211LT1/MMUN2212LT1/MMUN2213LT1	R1/R2	0.8	1.0	1.2	
	MMUN2214LT1	1	0.17	0.21	0.25	
	MMUN2215LT1/MMUN2216LT1	10	_	00 -	0 -	-02-
	MMUN2230LT1/MMUN2231LT1/MMUN2232LT1		0.8	1.0	1.2	
	MMUN2233LT1		0.055	0.1	0.185	
	MMUN2234LT1		0.38	0.47	0.56	



TYPICAL ELECTRICAL CHARACTERISTICS — MMUN2211LT1



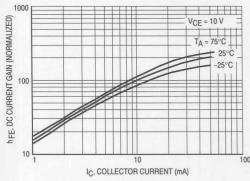


Figure 3. DC Current Gain

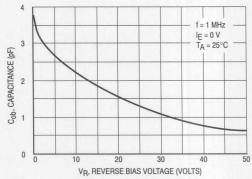


Figure 4. Output Capacitance

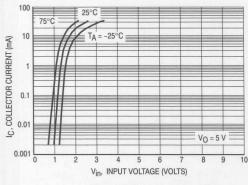


Figure 5. VCE(sat) versus IC

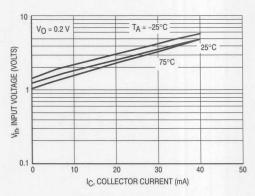


Figure 6. VCE(sat) versus IC

TYPICAL ELECTRICAL CHARACTERISTICS — MMUN2212LT1

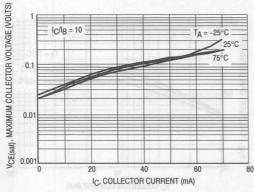


Figure 7. VCE(sat) versus IC

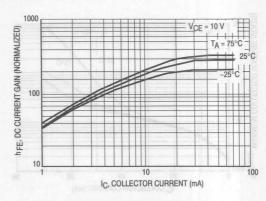


Figure 8. DC Current Gain

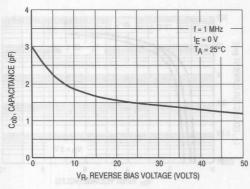


Figure 9. Output Capacitance

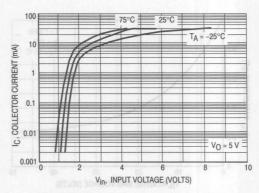


Figure 10. Output Current versus Input Voltage

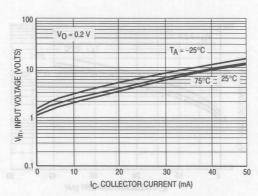


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MMUN2213LT1

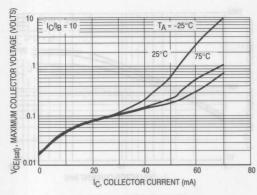


Figure 12. VCE(sat) versus IC

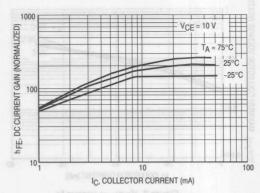


Figure 13. DC Current Gain

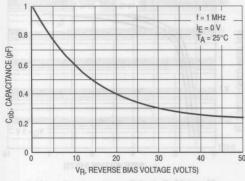


Figure 14. Output Capacitance

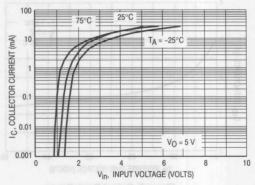


Figure 15. Output Current versus Input Voltage

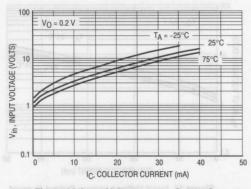


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MMUN2214LT1

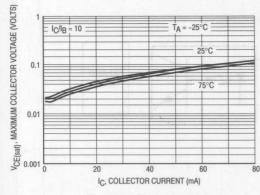


Figure 17. VCE(sat) versus IC

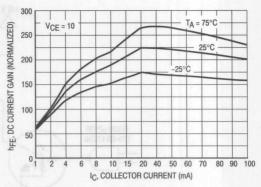


Figure 18. DC Current Gain

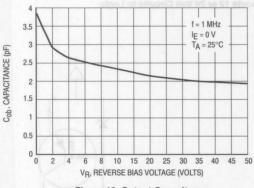


Figure 19. Output Capacitance

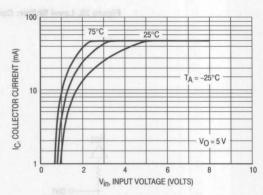


Figure 20. Output Current versus Input Voltage

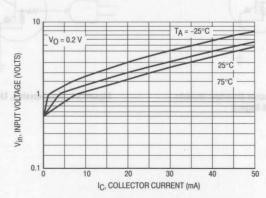


Figure 21. Input Voltage versus Output Current

TYPICAL APPLICATIONS FOR NPN BRTs

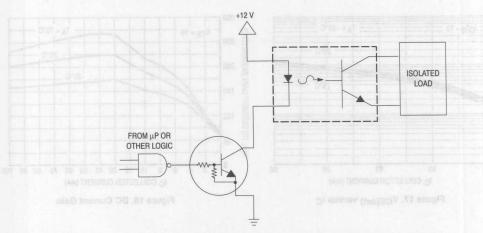


Figure 22. Level Shifter: Connects 12 or 24 Volt Circuits to Logic

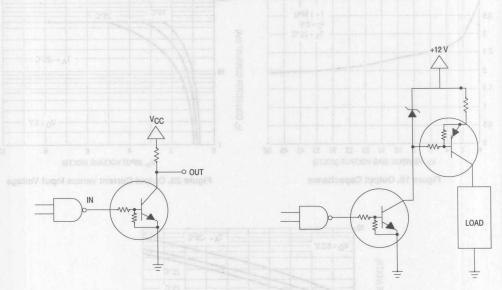


Figure 23. Open Collector Inverter: Inverts the Input Signal

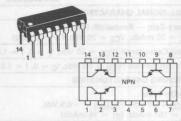
Figure 24. Inexpensive, Unregulated Current Source

Rating	Symbol	MPQ2222	MPQ2222A	Unit
Collector-Emitter Voltage	VCEO	30	40	Vdc
Collector-Base Voltage	VCBO	6	60	Vdc
Emitter-Base Voltage	VEBO	5.0		Vdc
Collector Current — Continuous	Ic	500		mAdc
26 08		Each Transistor	Total Device	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.65 5.2	1.9 15.2	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

THE HUMAE OFFICE OF THE THOU						
Characteristic	Symbol	Max	Unit			
Thermal Resistance, Junction to Ambient	RAJA	66	°C/W			

MPQ2222,A*



CASE 646-06, STYLE 1 TO-116

QUAD
GENERAL PURPOSE
TRANSISTORS
NPN SILICON

★MPQ2222A is a Motorola designated preferred device. Refer to MD2218 for graphs.

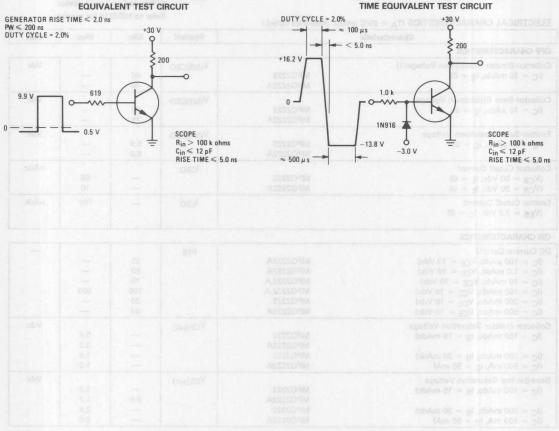
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS			2		
Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0)	MPQ2222 MPQ2222A	V(BR)CEO	40 40	=	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _E = 0)	MPQ2222 MPQ2222A	V(BR)CBO	60 75		Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)	MPQ2222 MPQ2222A	V(BR)EBO	5.0 6.0	ASP 4-	Vdc
Collector Cutoff Current $(V_{CB} = 50 \text{ Vdc}, I_E = 0)$ $(V_{CB} = 60 \text{ Vdc}, I_E = 0)$	MPQ2222 MPQ2222A	ICBO	Ξ	50 10	nAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0)		IEBO		100	nAdc
ON CHARACTERISTICS					
DC Current Gain(1) (IC = 100 µAdc, V _{CE} = 10 Vdc) (IC = 1.0 mAdc, V _{CE} = 10 Vdc) (IC = 10 mAdc, V _{CE} = 10 Vdc) (IC = 150 mAdc, V _{CE} = 10 Vdc) (IC = 300 mAdc, V _{CE} = 10 Vdc) (IC = 500 mAdc, V _{CE} = 10 Vdc)	MPQ2222A MPQ2222A MPQ2222,A MPQ2222,A MPQ2222 MPQ2222	hFE	35 50 75 100 30 40		_
Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) (I _C = 500 mA, I _B = 50 mA)	MPQ2222 MPQ2222A MPQ2222 MPQ2222A	VCE(sat)	Ē	0.4 0.3 1.6 1.0	Vdc
Base-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) (I _C = 500 mA, I _B = 50 mA)	MPQ2222 MPQ2222A MPQ2222 MPQ2222A	VBE(sat)	0.6	1.3 1.2 2.6 2.0	Vdc

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS	Mark Indianage Company				
Current-Gain — Bandwidth Product(1) (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	30 40 Vdc	fT	200	etgetleV vet	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		Cobo	_	8.0	pF
Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 1.0 MHz)		C _{ibo}	_	30	pF
SWITCHING CHARACTERISTICS					
Turn-On Time $(V_{CC} = 30 \text{ Vdc}, V_{BE(off)} = -0.5 \text{ Vdc},$	Eacht Tatal Sansistar Davice	ton	-	35	ns
I _C = 150 mAdc, I _{B1} = 15 mAdc)	MPQ2222A	97	O'BY - AT) notsejsal0	Device I
Turn-Off Time $(V_{CC} = 30 \text{ Vdc}, I_C = 150 \text{ mAdc}, I_{B1} = I_{B2} = 15 \text{ mAdc})$	MPQ2222A	^t off	nogo	285	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.



FIGURE 2 — STORAGE TIME AND FALL
TIME EQUIVALENT TEST CIRCUIT



Rating	Symbol	15 40 4.5		Unit
Collector-Emitter Voltage	VCEO			Vdc
Collector-Base Voltage	VCBO			Vdc
Emitter-Base Voltage	VEBO			Vdc
Collector Current — Continuous	lc	500		mAdc
E E E D D L M		Each Transistor	Total Device	1 1
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.5 5.0	1.5 15	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +125		°C

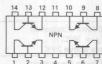
THERMAL CHARACTERISTICS

THE HIVE CHARACTERIO TICO							
	Characteristic	Symbol	Max	Unit			
	Thermal Resistance, Junction to Ambient	RAIA	83	°C/W			

MPQ2369*

CASE 646-06, STYLE 1 TO-116





QUAD SWITCHING TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device. Refer to MD2369 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	The second	-	- Land	- Annual of	
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0)	V(BR)CEO	15	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	gran Liptusi	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0)	V(BR)CBO	40	0 to T0-10	-	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V _{(BR)EBO}	4.5	6 16 <u>42</u> 0-10	_	Vdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0)	Ісво	-		0.4	μAdc
ON CHARACTERISTICS	Marine Annual Marine			SERVICE CO.	· varies was
DC Current Gain(1) $(I_C = 10 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$ $(I_C = 100 \text{ mAdc}, V_{CE} = 2.0 \text{ Vdc})$	hFE	40 20	I	otra <u>n</u> ato	URAHO R
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	V _{CE(sat)}	_12100	grigV_pwot	0.25	Vdc
Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	V _{BE(sat)}		- 16	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS			against the	New of about	or the se
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	fT	450	550	epb literal	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	-	2.5	4.0	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	C _{ibo}	_	3.0	5.0	pF
SWITCHING CHARACTERISTICS				ann dayr.	CHANGE
Turn-On Time $(V_{CC} = 3.0 \text{ Vdc}, V_{BE} = 1.5 \text{ Vdc}, I_{C} = 10 \text{ mAdc}, I_{B1} = 3.0 \text{ mAdc})$	ton		9.0	(3)oine	ns
Turn-Off Time ($V_{CC} = 3.0 \text{ Vdc}$, $I_{C} = 10 \text{ mAdc}$, $I_{B1} = 3.0 \text{ mAdc}$, $I_{B2} = 1.5 \text{ mAdc}$)	toff	-	15	-	ns

(1) Pulse Test: Pulse Width \leqslant 300 $\mu\text{s},$ Duty Cycle = 2.0%.

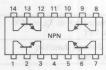
Rating	Symbol	Vs	lue	Unit
nating	Зуппоот	Value		
Collector-Emitter Voltage	VCEO	354	10	Vdc
Collector-Base Voltage	VCBO	ob (60	Vdc
Emitter-Base Voltage	VEBO	6	6.0	Vdc
Collector Current — Continuous	Ic	50		mAdc
A 5 5 日 5 日 5 日 5 日 5 日 5 日 5 日 5 日 5 日	III,	Each Transistor	Four Transistors Equal Power	desi intsino 8.0
Total Device Dissipation @ T _A = 25°C(1) Derate above 25°C	PD	500 4.0	900 7.2	mW mW/°0
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	0.825 6.7	2.4 19.2	Watts mW/°0
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 t	°C	

(1) Second Breakdown occurs at power levels greater than 3 times the power dissipation rating.

MPQ2483 MPQ2484*

CASE 646-06, STYLE 1 TO-116





QUAD AMPLIFIER TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

THERMAL CHARACTERISTICS

Charac	eteristic	Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die Effective, 4 Die	151 52	250 134	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	34 2.0	70 26	%

Characteristi	ic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS			2.6 Vdc)	- and July	len 001 = 2	50	
Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0)	(7n=130V	(abAm 0:1	V(BR)CEO	40	stlo v rolte	none c ieni	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _E = 0)	1 Useing?	1	V(BR)CBO	60	HTENESTOA	NAL CHAN	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)	13		V _{(BR)EBO}	6.0	- 10 Vde.	Egindw nAds, Vos	Vdc
Collector Cutoff Current (V _{CB} = 45 Vdc, I _E = 0)	odo		ІСВО	(diM	0.1 = 1.0	20	nAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0)	oulo		I _{EBO}	Ext-tive	0.1 - 1.0	20	nAdc
ON CHARACTERISTICS					2001 2053	I WARRANCE	MINATEN
DC Current Gain(2) $(I_C = 0.1 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$	nol Bel	MPQ2483 MPQ2484	hFE	100 200	pbV <u>8.7 =</u>	er Hei	int n <u>O-mi</u> is = 3399 int #O-mi
$(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$		MPQ2483 MPQ2484	1 = 20% = 0	150 300	apAm GF	NA BENG	E = 30V) Pulse Test
$(I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$		MPQ2483 MPQ2484		150 300	=	=	
Collector-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 0.1 mAdc) (I _C = 10 mAdc, I _B = 1.0 mAdc)			VCE(sat)	=	0.13 0.15	0.35 0.5	Vdc
Base-Emitter Saturation Voltage(2) (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc)			VBE(sat)	=	0.58 0.70	0.7 0.8	Vdc

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
SMALL-SIGNAL CHARACTERISTICS		MPOJSOT	todany8		ani di	
Current-Gain — Bandwidth Product (I _C = 500 μAdc, V _{CE} = 5.0 Vdc, f = 20 MHz)	abV \$8 -	fT	50	100	iner <u>V</u> oltuge se Voltuge	MHz
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	obV (C _{ibo}	0837	4.0	8.0	pF
Collector-Base Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	letu?"	C _{cb}	-	1.8	6.0	pF
Noise Figure (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k ohms, f = 1.0 kHz, BW = 10 kHz)	MPQ2483 MPQ2484	NF	g/i	3.0 2.0	notic <u>ul</u> esiQ eva 2 <u>87</u> 0	dB

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

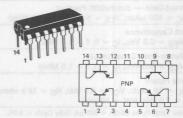
Rating	Symbol	MPQ2906 MPQ2907	MPQ2907A	Unit
Collector-Emitter Voltage	VCEO	-40	-60	Vdc
Collector-Base Voltage	VCBO	_	60	Vdc
Emitter-Base Voltage	VEBO	-5.0		Vdc
Collector Current — Continuous	— Continuous I _C −600		mAdc	
14 0.0 8.1		Each Transistor	Total Device	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.65 6.5	1.9 19	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +125		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	Rela	66	°C/W

MPQ2906 MPQ2907,A*

CASE 646-06, STYLE 1 TO-116



QUAD GENERAL PURPOSE TRANSISTORS

PNP SILICON

★MPQ2907A is a Motorola designated preferred device.

-0.4

-1.6

-1.6

-1.3

-2.6

-2.6

Vdc

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) $(I_C = -10 \text{ mAdc}, I_B = 0)$	MPQ2906, MPQ2907 MPQ2907A	V _(BR) CEO	-40 -60	_	Vdc
Collector-Base Breakdown Voltage (I _C = -10μ Add	, I _E = 0)	V(BR)CBO	-60	_	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc, I_C = 0$)		V(BR)EBO	-5.0	_	Vdc
Collector Cutoff Current (V _{CB} = -30 Vdc, I _E = 0) (V _{CB} = -50 Vdc, I _E = 0)	MPQ2906, MPQ2907 MPQ2907A	ICBO		-50	nAdc
Emitter Cutoff Current ($V_{EB} = -3.0 \text{ Vdc}$, $I_{E} = 0$)	MPQ2906,7 Only	IEBO	_	-50	nAdc
ON CHARACTERISTICS					
DC Current Gain(1) $ \begin{aligned} &(I_C = -100 \; \mu \text{Adc, V}_{CE} = -10 \; \text{Vdc}) \\ &(I_C = -1.0 \; m \text{Adc, V}_{CE} = -10 \; \text{Vdc}) \\ &(I_C = -1.0 \; \text{mAdc, V}_{CE} = -10 \; \text{Vdc}) \\ &(I_C = -10 \; \text{mAdc, V}_{CE} = -10 \; \text{Vdc}) \\ &(I_C = -150 \; \text{mAdc, V}_{CE} = -10 \; \text{Vdc}) \\ &(I_C = -150 \; \text{mAdc, V}_{CE} = -10 \; \text{Vdc}) \\ &(I_C = -300 \; \text{mAdc, V}_{CE} = -10 \; \text{Vdc}) \\ &(I_C = -500 \; \text{mAdc, V}_{CE} = -10 \; \text{Vdc}) \end{aligned} $	MPQ2907A MPQ2907A MPQ2906 MPQ2907 MPQ2907A MPQ2907A MPQ2906 MPQ2907 MPQ2906 MPQ2907	hFE	75 100 35 75 100 100 40 100 20 30 50	300	-
Collector-Emitter Saturation Voltage(1)		V _{CE(sat)}			Vdc
//- 450 - 44- 1 45 - 413		JE (Sut)			

MPQ2906, MPQ2907

MPQ2906, MPQ2907

MPQ2906, MPQ2907

MPQ2907A

MPQ2907A

 $\begin{array}{ll} (I_{C} = -150 \text{ mAdc}, I_{B} = -15 \text{ mAdc}) \\ (I_{C} = -300 \text{ mAdc}, I_{B} = -30 \text{ mAdc}) \\ (I_{C} = -500 \text{ mA}, I_{B} = -500 \text{ mA}) \end{array}$

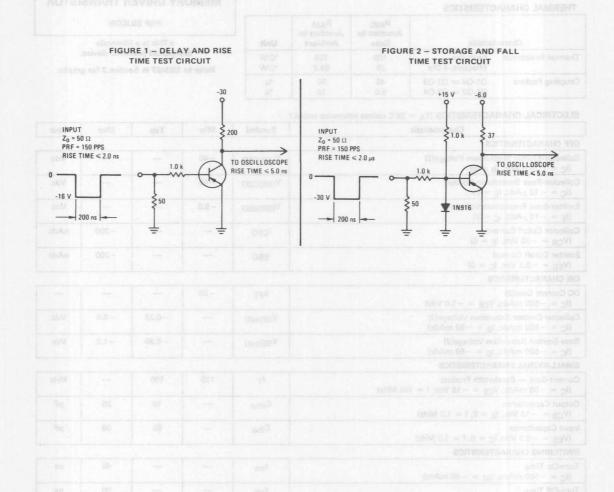
Base-Emitter Saturation Voltage(1) $\begin{array}{ll} \text{(I}_C = -150 \text{ mAdc, I}_B = -15 \text{ mAdc)} \\ \text{(I}_C = -300 \text{ mAdc, I}_B = -30 \text{ mAdc)} \\ \text{(I}_C = -500 \text{ mA, I}_B = -50 \text{ mA)} \end{array}$

V_{BE}(sat)

ELECTRICAL CHARACTERISTICS — Continued (TA = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS	Avde	0.6-	3	20003	ni — Comin	emug rojselli
Current-Gain — Bandwidth Product (I _C = -50 mAdc, V _{CE} = -20 Vdc, f = 100 MHz)		Four dots Tennistors	fT	200	-	MHz
Output Capacitance, $(V_{CB} = -10 \text{ Vdc}, I_E = 0, f = 1.$.0 MHz)	sacros tungel versus	Cobo		8.0	pF
Input Capacitance, (VEB = 2.0 Vdc, IC = 0, f = 1.0 M	ΛHz)	nost to	Cibo	_	30	pF
SWITCHING CHARACTERISTICS	Drivin	12 12			285	ovodo stateľ
Turn-On Time $(V_{CC} = -30 \text{ Vdc}, I_C = -150 \text{ mAdc}, I_{B1} = 15 \text{ mAdc})$	MPQ2907	7A Only	ton of	-	45	ns
Turn-Off Time $(V_{CC} = -6.0 \text{ Vdc}, I_C = -150 \text{ mAdc}, I_{B1} = I_{B2} = 15 \text{ mAdc})$	MPQ2907	7A Only	toff	-notte	180	emperatura

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.



Rating	Symbol	Va	Unit	
Collector-Emitter Voltage	VCEO		-40	
Collector-Base Voltage	VCBO	Conten ons	-40	Vdc
Emitter-Base Voltage	VEBO	-	5.0	Vdc
Collector Current — Continuous	Ic	-	1.0	Adc
SHIV 00S	P	Each Transistor	Four Transistors Equal Power	
Total Device Dissipation @ T _A = 25°C(1) Derate above 25°C	PD	650 5.2	1500 12	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.25 10	3.2 25.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 t	°C	

(1) Second Breakdown occurs at power levels greater than 2 times the power dissipation rating.

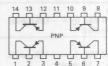
THERMAL CHARACTERISTICS

Charac	teristic	R _B JC Junction to Case	R _B JA Junction to Ambient	Unit
Thermal Resistance	Each Die Effective, 4 Die	100 39	193 83.2	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	45 5.0	55 10	%

MPQ3467*

CASE 646-06, STYLE 1 TO-116





QUAD MEMORY DRIVER TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

Refer to 2N3467 in Section 3 for graphs.

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS		1000		291.00	00 m 624 - 0-7899
Collector-Emitter Breakdown Voltage(2) (I _C = -10 mAdc, I _B = 0)	V(BR)CEO	-40	(0.1	10 <u>37</u> × 3 H	Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc$, $I_E = 0$)	V(BR)CBO	-40		-	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc$, $I_C = 0$)	V _{(BR)EBO}	-5.0		- in 0	Vdc
Collector Cutoff Current $(V_{CB} = -30 \text{ Vdc}, I_E = 0)$	СВО	-	-	-200	nAdc
Emitter Cutoff Current $(V_{EB} = -3.0 \text{ Vdc}, I_C = 0)$	IEBO	-	-	-200	nAdc
ON CHARACTERISTICS					
DC Current Gain(2) ($I_C = -500 \text{ mAdc}$, $V_{CE} = -1.0 \text{ Vdc}$)	hFE	-20	-	-	-
Collector-Emitter Saturation Voltage(2) (I _C = -500 mAdc, I _B = -50 mAdc)	V _{CE} (sat)		-0.23	-0.5	Vdc
Base-Emitter Saturation Voltage(2) $(I_C = -500 \text{ mAdc}, I_B = -50 \text{ mAdc})$	V _{BE(sat)}	-	-0.90	-1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = -50 mAdc, V _{CE} = -10 Vdc, f = 100 MHz)	fT	125	190	-	MHz
Output Capacitance ($V_{CB} = -10 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C _{obo}	-	10	25	pF
Input Capacitance ($V_{EB} = -0.5 \text{ Vdc}$, $I_{C} = 0$, $f = 1.0 \text{ MHz}$)	C _{ibo}	-	55	80	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (I _C = -500 mAdc, I _{B1} = -50 mAdc)	ton	_	-	40	ns
Turn-Off Time (I _C = -500 mAdc, I _{B1} = I _{B2} = -50 mAdc)	toff	-	-	90	ns

MAXIMOM MATIMOS				
Rating	Symbol	Value		Unit
Collector-Emitter Voltage	VCEO	40		Vdc
Collector-Emitter Voltage	VCES	60		Vdc
Emitter-Base Voltage	VEBO	5.0		Vdc
Collector Current — Continuous	Ic	1.0		Adc
		One Transistor	Four Transistors Equal Power	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

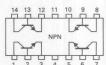
Characteristics	Symbol	Max		Unit
an an	20.0.0 0	One Transistor	Effective For Four Transistors	0
Thermal Resistance, Junction to Ambient(1)	$R_{\theta JA}$	125	50	°C/W

(1) $R_{ heta JA}$ is measured with the device soldered into a typical printed circuit board.

MPQ3725*

CASE 646-06, STYLE 1 TO-116





QUAD CORE DRIVER TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Refer to MM3725 in Section 3 for graphs.

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0)	V(BR)CEO	40	-	-	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100 \mu Adc, V_{BE} = 0$)	V(BR)CES	60		-	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc$, $I_C = 0$)	V(BR)EBO	5.0	-	-	Vdc
Collector Cutoff Current (V _{CB} = 40 Vdc, I _E = 0)	ICBO		-	0.5	μAdc
ON CHARACTERISTICS(2)				HE COURT	
DC Current Gain (I _C = 100 mAdc, V_{CE} = 1.0 Vdc) (I _C = 500 mAdc, V_{CE} = 2.0 Vdc)	hFE	35 25	75 45	200	-
Collector-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc)	VCE(sat)	1-1	0.32	0.45	Vdc
Base-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc)	V _{BE(sat)}	0.8	0.9	1.1	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	fT	250	275	-	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}		5.1	10	pF

Cibo

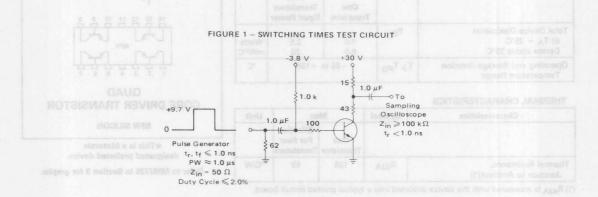
(VEB = 0.5 Vdc, I_C = 0, f = 1.0 MHz) (2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Input Capacitance

pF

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
SWITCHING CHARACTERISTICS	vejsV	Symbol .		gnitsB	
Turn-On Time (I _C = 500 mAdc, I _{B1} = 50 mAdc, V _{BE(off)} = -3.8 Vdc)	ton	03 0 4	20	35	ns
Turn-Off Time (I _C = 500 mAdc, I _{B1} = I _{B2} = 50 mAdc)	toff	casV	50	60	ns



Rating	Symbol	Value		Unit	
Collector-Emitter Voltage	VCEO	SYMA	-40		
Collector-Base Voltage	VCBO		-40		
Emitter-Base Voltage	V _{EBO}	_	Vdc		
Collector Current — Continuous	Ic		-1.5		
D 001	0 -4 57	Each Transistor	Four Transistors Equal Power		
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	750 5.98	1700 13.6	mW mW/°C	
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.25 10	3.2 25.6	Watts mW/°C	
Operating and Storage Junction Temperature Range	T _J , T _{stg}	- 55 t	0 +150	°C	

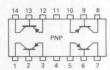
THERMAL CHARACTERISTICS

Characte	eristic	Junction to Case	Junction to Ambient	Unit
Thermal Resistance(1)	Each Die Effective, 4 Die	100 39	167 73.5	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	46 5.0	56 10	%

MPQ3762

CASE 646-06, STYLE 1 TO-116





QUAD MEMORY DRIVER TRANSISTOR

PNP SILICON

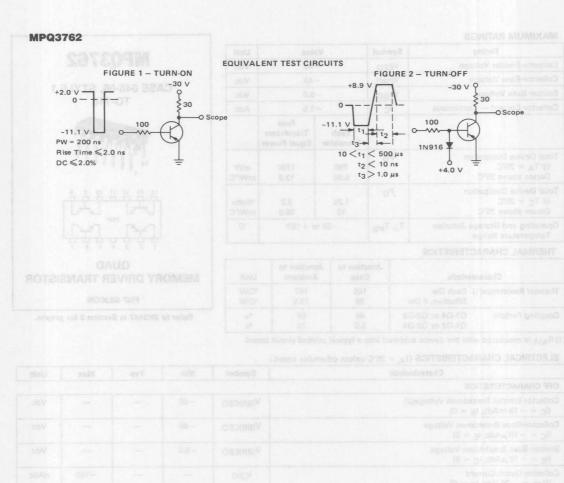
Refer to 2N3467 in Section 3 for graphs.

(1) $R_{ heta JA}$ is measured with the device soldered into a typical printed circuit board.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) $(I_C = -10 \text{ mAdc}, I_B = 0)$	V _(BR) CEO	-40	-	-	Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc$, $I_E = 0$)	V(BR)CBO	-40	-		Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc, I_C = 0$)	V _{(BR)EBO}	-5.0	-	-	Vdc
Collector Cutoff Current $(V_{CB} = -30 \text{ Vdc}, I_{E} = 0)$	ICBO	-	-	-100	nAdc
Emitter Cutoff Current (V _{EB} = -3.0 Vdc, I _C = 0)	I _{EBO}	_	_	-100	nAdc
ON CHARACTERISTICS(2)					
DC Current Gain $(I_C = -150 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})$ $(I_C = -500 \text{ mAdc}, V_{CE} = -2.0 \text{ Vdc})$ $(I_C = -1.0 \text{ Adc}, V_{CE} = -2.0 \text{ Vdc})$	hFE	35 30 20	70 65 35	=	-
Collector-Emitter Saturation Voltage ($I_C = -500 \text{ mAdc}$, $I_B = -50 \text{ mAdc}$) ($I_C = -1.0 \text{ Adc}$, $I_B = -100 \text{ mAdc}$)	VCE(sat)	=	-0.3 -0.6	- 0.55 - 0.9	Vdc
Base-Emitter Saturation Voltage ($I_C = -500 \text{ mAdc}$, $I_B = -50 \text{ mAdc}$) ($I_C = -1.0 \text{ Adc}$, $I_B = -100 \text{ mAdc}$)	VBE(sat)	=	- 0.9 - 1.0	- 1.25 - 1.4	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I _C = -50 mAdc, V _{CE} = -10 Vdc, f = 100 MHz)	fΤ	150	275	-	MHz
Output Capacitance ($V_{CB} = -10 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	Cobo	_	9.0	15	pF
Input Capacitance ($V_{EB} = -0.5 \text{ Vdc}$, $I_{C} = 0$, $f = 1.0 \text{ MHz}$)	C _{ibo}		55	80	pF
SWITCHING CHARACTERISTICS					
Turn-On Time $(V_{CC} = -30 \text{ Vdc}, I_C = -1.0 \text{ Adc}, I_{B1} = -100 \text{ mAdc}, V_{BE(off)} = 2.0 \text{ Vdc})$	^t on		_	50	ns
Turn-Off Time $(V_{CC}=-30\ Vdc,\ I_C=-1.0\ Adc,\ I_{B1}=I_{B2}=-100\ mAdc)$	toff		-	120	ns

(2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.



Rating		Symbol	MPQ3798	MPQ3799	Unit
Collector-Emitter Voltage		VCEO	-40	-60	Vdc
Collector-Base Voltage	0/3	VCBO	-60		Vdc
Emitter-Base Voltage		V _{EBO} -5.0			Vdc
Collector Current — Continu	lous	Ic	1 11-	-50	mAdc
9q 0.6	rs		Each Transistor	Four Transistors Equal Power	
Total Device Dissipation @ T _A = 25°C(1) Derate above 25°C	8.8	PD	0.5 4.0	0.9 7.2	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	2.5	PD	0.825 6.7	2.4 19.2	Watts m/°C
Operating and Storage June Temperature Range	T _J , T _{stg}	-55 1	to +150	°C	

(1) Second breakdown occurs at power levels greater than 3 times the power dissipation rating.

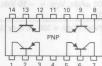
THERMAL CHARACTERISTICS

Charac	teristic	R _Ø JC Junction to Case	R _B JA Junction to Ambient	Unit
Thermal Resistance	Each Die Effective, 4 Die	151 52	250 139	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	34 2.0	70 26	%

MPQ3798 MPQ3799*

CASE 646-06, STYLE 1 TO-116





QUAD AMPLIFIER TRANSISTORS

PNP SILICON

★This is a Motorola designated preferred device.

Refer to 2N3810 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit	
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(2) (I _C = -10 mAdc, I _B = 0)	MPQ3798 MPQ3799	V(BR)CEO	-40 -60	_	=	Vdc
Collector-Base Breakdown Voltage (I _C = -10μ Adc, I _E = 0)		V _(BR) CBO	-60		_	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc$, $I_C = 0$)		V _{(BR)EBO}	-5.0	-	-	Vdc
Collector Cutoff Current (V _{CB} = -50 Vdc, I _E = 0)		ICBO	-	1-	-10	nAdc
Emitter Cutoff Current (V _{EB} = -3.0 Vdc, I _C = 0)		IEBO	-	-	-20	nAdc
ON CHARACTERISTICS						3 76
DC Current Gain (I _C = $-10 \mu Adc$, V _{CE} = $-5.0 Vdc$)	MPQ3798 MPQ3799	hFE	100 225	7=1	=	-
$(I_{C} = -100 \ \mu Adc, V_{CE} = -5.0 \ Vdc)$	MPQ3798 MPQ3799		150 300	=	Ξ	
$(I_C = -500 \ \mu Adc, V_{CE} = -5.0 \ Vdc)$	MPQ3798 MPQ3799		150 300	=	=	
$(I_C = -10 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc})$	MPQ3798 MPQ3799		125 250	==	Ξ	
Collector-Emitter Saturation Voltage (I _C = -100μ Adc, I _B = -10μ Adc) (I _C = -1.0μ Adc)		VCE(sat)	=	-0.12 -0.07	-0.2 -0.25	Vdc
Base-Emitter Saturation Voltage ($I_C = -100 \mu Adc$, $I_B = -10 \mu Adc$) ($I_C = -1.0 \mu Adc$)		V _{BE(sat)}	Ξ	-0.62 -0.68	-0.7 -0.8	Vdc

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

	Symbol	Min	Тур	Max	Unit
bV -	-6.0	LO83V		egatoV v	ass remi
Ant	fT	60	250	no) — usn	MHz
ranslators uni Power	C _{obo}	-	2.1	4.0	pF
W 6.0	C _{ibo}	10	5.5	8.0	pF
MPQ3798	NF	-1	2.5	Diss ave	dB
	Verman Power Co. S. W. Co. S. Co	fT Cobo Cibo NF MPQ3798	f _T 60 C _{obo} — C _{ibo} — MPQ3798 —	fT 60 250 Cobo — 2.1 Cibo — 5.5 MPQ3798 — 2.5	f _T 60 250 — C _{obo} — 2.1 4.0 C _{ibo} — 5.5 8.0 MPQ3798 — 2.5 —

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤		(2) Pulse	Test: Pulsi	e Width	≤ 31	00 us.	Duty	Cycle	\$	2.0%	١.
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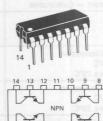
Rating	Symbol	Va	alue	Unit
Collector-Emitter Voltage	VCEO	ch// d	40	Vdc
Collector-Base Voltage	VCBO	shvite shvit	60	Vdc
Emitter-Base Voltage	VEBO	6.0		Vdc
Collector Current — Continuous	Ic	200		mAdc
Wive.		Each Transistor	Four Transistors Equal Power	di
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	500 4.0	900 7.2	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	825 6.7	2.4 19.2	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 t	0 +150	or °C

THERMAL CHARACTERISTICS

Charac	teristic	Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die Effective, 4 Die	151 52	250 139	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	34 2.0	70 26	% %

MPQ3904★

CASE 646-06, STYLE 1 TO-116



QUAD AMPLIFIER SWITCHING TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device. Refer to 2N3904 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

ristic	industria	Symbol	Min	Тур	Max	Unit
01-	OSCINEDA	V _(BR) CEO	40	Sown_Volts = (0)	sins <u>t p</u> anta gilabAm 0	Vdc
94-	ово(на)У	V(BR)CBO	60	iva V <u>o</u> tage (0)	grubAk (Vdc
0,8-	COSTABLY	V(BR)EBO	6.0	sp <u>stlo</u> V n	aba <u>a</u> ara (gl.at-As (Vdc
	080	ІСВО	_	10. =	50	nAdc
	ONE	IEBO	_	10 =	50	nAdo
					S. M. FELVELLE	ANAHO
40 00 75	35/7	hFE	30 50 75	90 160 200	nieu V ph <u>A</u> de, V o phAde, V o ma_de, V _C	met <u>lu</u> 0 0 = 0 1 = 0
	VCE(ser)	VCE(sat)	- lab	0.1	0.2	Vdc
	(160) HEV	V _{BE(sat)}	(sb)	0.65	0.85	Vdc
				OFFERNATION	VAL CHARLE	DIE-LUA
0 MHz)		fT	250	300	V ntAm (MHz
	0000	C _{obo}	- (vHM o	2.0	4.0	pF
	260	C _{ibo}	GHM 0	4.0	8.0	pF
				5311 SH	T-MASOURIAL	UMB NATE
B1 = 1.0	mAdc)	ton	rgl abV	37	eV obAm (ns
)	1101	toff	phAm 0.1	136	gi abAmi	ns
	0 MHz)	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	V(BR)CEO V(BR)CBO V(BR)EBO ICBO IEBO PFE VCE(sat) VBE(sat) TCobo Cibo toff	V(BR)CEO 40 V(BR)CBO 60 V(BR)EBO 6.0	V(BR)CEO 40	V(BR)CEO 40 - -

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

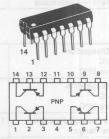
Rating	Symbol	V	Unit	
Collector-Emitter Voltage	VCEO	300%	Vdc	
Collector-Base Voltage	VCBO	StV-	-40	Vdc
Emitter-Base Voltage	VEBO	1001	5.0	Vdc
Collector Current — Continuous	Ic	-200		mAdc
No.		Each Transistor	Four Transistors Equal Power	do retes
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	500 4.0	900 7.2	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	825 6.7	2.4 19.2	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

Charac	teristic	Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die Effective, 4 Die	151 52	250 139	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	34 2.0	70 26	% %

MPQ3906*

CASE 646-06, STYLE 1 TO-116



QUAD AMPLIFIER SWITCHING TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device. Refer to 2N3906 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	lodow2	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) (I _C = -1.0 mAdc, I _B = 0)	Yanıca	V _(BR) CEO	-40	wn Vortager	nower in the second	Vdc
Collector-Base Breakdown Voltage (I _C = -10 μAdc, I _E = 0)	SO(BRICE	V(BR)CBO	-40	ogulleV r	e Broskdown Ado M = 0)	Vdc
Emitter-Base Breakdown Voltage $(I_E = -10 \mu Adc, I_C = 0)$	03(88)¥	V _{(BR)EBO}	-5.0	agetio)	nwoodeere	Vdc
Collector Cutoff Current (V _{CB} = -30 Vdc, I _E = 0)	080	ICBO	_	-	-50	nAdc
Emitter Cutoff Current (V _{EB} = -4.0 Vdc, I _C = 0)	Casi	IEBO		-	-50	nAdc
ON CHARACTERISTICS(1)					nann algari	TARRIED I
DC Current Gain	Mari	hFE	40 60 75	160 180 200	niei nAde.Vgg = nAde.Vgg =	Current (C = 0.1)
Collector-Emitter Saturation Voltage (I _C = -10 mAdc, I _B = -1.0 mAdc)	VDEJeal	V _{CE(sat)}		-0.1	-0.25	Vdc
Base-Emitter Saturation Voltage (I _C = -10 mAdc, I _B = -1.0 mAdc)	test30V	V _{BE(sat)}		-0.65	-0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS				RING PARTY	MARAHO IAM	DIS. LIAN
Current-Gain — Bandwidth Product (I _C = -10 mAdc, V _{CE} = -20 Vdc, f = 100 MH	łz)	fT	200	250	biwbies —	MHz
Output Capacitance (V _{CB} = -5.0 Vdc, I _E = 0, f = 1.0 MHz)	outo ²	C _{obo}	_	3.3	4.5	pF
Input Capacitance (V _{EB} = -0.5 Vdc, I _C = 0, f = 1.0 MHz)	odi?	C _{ibo}		4.8	10	pF
SWITCHING CHARACTERISTICS				porter	STARREN	CHARLES THE
Turn-On Time $(I_C = -10 \text{ mAdc}, V_{BE(off)} = 0.5 \text{ Vdc}, I_{B1} = -10 \text{ mAdc})$	1.0 mAdc)	t _{on}		43	- Francisco	ns
Turn-Off Time $(I_C = -10 \text{ mAdc}, I_{B1} = I_{B2} = -1.0 \text{ mAdc})$	tiof	toff		155		ns

FIGURE 1 – DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

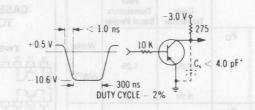
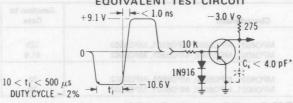


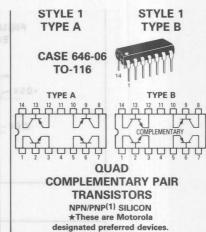
FIGURE 2 – STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



*Total shunt capacitance of test jig and connectors

PATARY PAIR

Emitter-Base Voltage	VEBO	5.0		Vdc
Collector Current — Continuous	Ic	5	00	mAdc
		Each Transistor	Four Transistors Equal Power	
Total Device Dissipation @ T _A = 25°C(1) MPQ6001, MPQ6002, MPQ6501,	PD		AU	Watts
MPQ6502 Derate above 25°C MPQ6001, MPQ6002, MPQ6501, MPQ6502	*ia 0.1	0.65	1.25	mW/°C
Total Device Dissipation @ T _C = 25°C MPQ6001, MPQ6002, MPQ6501,	PD	0.10		Watts
MPQ6502 Derate above 25°C MPQ6001, MPQ6002, MPQ6501, MPQ6502		1.0	3.0	mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 t	o +150	°C



THERMAL CHARACTERISTICS

	Characteristic	Junction to Case	Junction to Ambient	Unit
Thermal Resistance Each Die Effective, 4 Die	MPQ6001, MPQ6002, MPQ6501, MPQ6502 MPQ6001, MPQ6002, MPQ6501, MPQ6502	125 41.6	193 100	°C/W
Coupling Factors Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	MPQ6001, MPQ6002, MPQ6501, MPQ6502 MPQ6001, MPQ6002, MPQ6501, MPQ6502	30	60 24	%

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characterist	tic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(2) (IC	= 10 mAdc, I _B = 0)	V(BR)CEO	30	_	_	Vdc
Collector-Base Breakdown Voltage (I _C = 1	0 μAdc, I _E = 0)	V(BR)CBO	60	_	_	Vdc
Emitter-Base Breakdown Voltage (I _E = 10	μ Adc, I _C = 0)	V(BR)EBO	5.0	_	_	Vdc
Collector Cutoff Current (V _{CB} = 50 Vdc, I _E	= 0)	Ісво		_	30	nAdo
Emitter Cutoff Current (VEB = 3.0 Vdc, IC	= 0)	IEBO	_	_	30	nAdo
ON CHARACTERISTICS						
DC Current Gain(2)		hFE				_
$(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$	MPQ6001, MPQ6501		25	_	_	
	MPQ6002, MPQ6502		50	_	_	
(I _C = 10 mAdc, V _{CF} = 10 Vdc)	MPQ6001, MPQ6501		35	_	-	
	MPQ6002, MPQ6502		75	_	-	1
(I _C = 150 mAdc, V _{CF} = 10 Vdc)	MPQ6001, MPQ6501		40		_	
SE SE	MPQ6002, MPQ6502		100	_	-	
(I _C = 300 mAdc, V _{CF} = 10 Vdc)	MPQ6001, MPQ6501		20		_	
JL SE	MPQ6002, MPQ6502		30	_	_	

⁽¹⁾ Voltage and Current are negative for PNP Transistors.

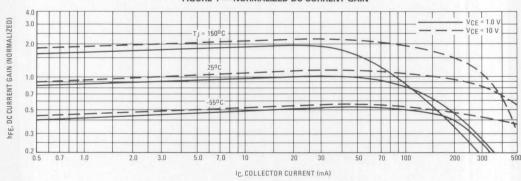
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

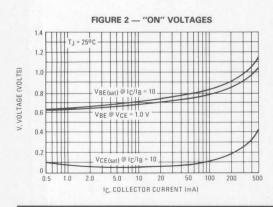
Characteristic	10 Veta T A = 25°CI	Symbol	Min	Тур	Max	Unit
Collector-Emitter Saturation Voltage(2) (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc)	noon	VCE(sat)	rovellean	1-035U	0.4 1.4	Vdc
Base-Emitter Saturation Voltage(2) (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc)	A 100 g	V _{BE} (sat)	<u> </u>	=	1.3 2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS	03 2	hardi - p				
Current-Gain — Bandwidth Product(2) (I _C = 50 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)		ft	200	350	1	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	PNP NPN	C _{obo}		6.0 4.5	8.0 8.0	pF
Input Capacitance ($V_{EB}=2.0\ Vdc,\ I_{C}=0,\ f=1.0\ MHz$)	PNP NPN	C _{ibo}	13	20 17	30 30	pF
SWITCHING CHARACTERISTICS			FERNI A 2118 I	Indian's Paris		
Turn-On Time $(V_{CC}=30\ Vdc,\ V_{EB}=0.5\ Vdc,\ I_{C}=150\ mAdc,\ I_{B1}=15\ mAdc,\ Figure 1)$		ton	Ī	30	-	ns
Turn-Off Time ($V_{CC} = 30 \text{ Vdc}$, $I_C = 150 \text{ mAdc}$, $I_{B1} = I_{B2} = 15 \text{ mAdc}$)		^t off	-	225	-	ns

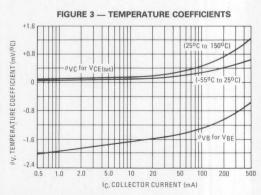
⁽¹⁾ Second Breakdown occurs at power levels greater than 3 times the power dissipation rating.

NPN DATA

FIGURE 1 — NORMALIZED DC CURRENT GAIN

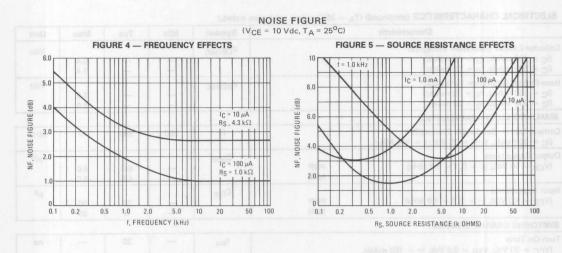






⁽²⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

MPQ6001 MPQ6002 MPQ6501 MPQ6502



Rating	Symbol	MPQ	Unit			
Collector-Emitter Voltage	VCEO		45	Vdc		
Collector-Base Voltage	VCBO		60	Vdc		
Emitter-Base Voltage	VEBO	(Joston 9	5.0	Vdc		
Collector Current — Continuous	Ic	50		50		mAdc
0.8 — 0.8 —		Each Transistor	Four Transistors Equal Power	18		
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	500 4.0	900 7.2	mW mW/°C		
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	0.825 6.7	2.4 19.2	Watts mW/°C		
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150		°C		

THERMAL CHARACTERISTICS

Characte	eristic	Junction to Case	Junction to Ambient	Unit
Thermal Resistance(1)	Each Die Effective, 4 Die	151 52	250 139	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	34 2.0	70 26	% %

(1) $R_{ heta JA}$ is measured with the device soldered into a typical printed circuit board.

MPQ6100A STYLE 1 TYPE A MPQ6600A1 STYLE 1 TYPE B CASE 646-06 TO-116 TYPE A TYPE B COMPLEMENTARY OUAD COMPLEMENTARY PAIR TRANSISTORS

NPN/PNP(1) SILICON

★This is a Motorola
designated preferred device.

Refer to 2N3799 in Section 3 for PNP Curves.

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) MPQ6100A,6600A1	V _(BR) CEO	45	_		Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _E = 0)	V _(BR) CBO	60		_	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V _{(BR)EBO}	5.0	_	_	Vdc
Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0)	ICBO	_	_	10	nAdo
ON CHARACTERISTICS(2)		MYMM			
DC Current Gain	hFE	100 150 150 125	- - -	=	
Collector-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 100 µAdc)	V _{CE(sat)}	<u>-</u>	-	0.25	Vdc
Base-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 100 μAdc)	V _{BE(sat)}	T	-	0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = 500 µAdc, V _{CE} = 5.0 Vdc, f = 20 MHz)	fT	50	-	- 1	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz) PNP NPN	C _{obo}		1.2 1.8	4.0 4.0	pF

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
Input Capacitance (VEB = 0.5 Vdc, IC = 0 , f = 1.0 MHz)	PNP NPN	C _{ibo}	=	=	8.0 8.0	pF
Noise Figure $(I_C = 100 \mu\text{Adc}, V_{CE} = 5.0 \text{Vdc}, R_S = 10 \text{k} \text{ohms}, \ f = 1.0 \text{kHz}, \text{BW} = 10 \text{kHz})$		NF 000	. .	4.0	Dissipation BC	dB

MATCHING CHARACTERISTICS (MPO6600A1 ONLY)

DC Current Gain Ratio (I _C = 100 μAdc, V _{CF} = 5.0 Vdc)	h _{FE1} /h _{FE2}	0.8	-	1.0	(a) T _C = (b)
Base-Emitter Voltage Differential (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc)	VBE1-VBE2	DIAT OT	Bonu	20	mVdc

⁽¹⁾ Voltage and Current are negative for PNP Transistors.

⁽²⁾ Pulse Test: Pulse Width ≤ 300 μs. Duty Cycle ≤ 2.0%.

Rating	Symbol	V	Unit	
Collector-Emitter Voltage	VCEO	30		Vdc
Collector-Base Voltage	VCBO	10995	40	Vdc
Emitter-Base Voltage	VEBO	100	12	Vdc
Collector Current — Continuous	Ic		500	mAdc
-H 0.1 - HTGINOMAR		Each Die	Four Die Equal Power	
Total Device Dissipation @ TA = 25°C(1) Derate above 25°C	PD	500 4.0	900 7.2	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	825 6.7	2400 19.2	mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55	°C	

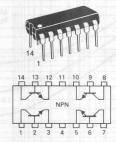
(1) Second Breakdown occurs at power levels greater than 3 times the power dissipation rating.

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die Effective, 4 Die	151 52	250 139	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	34 2.0	70 26	%

MPQ6426

CASE 646-06, STYLE 1 TO-116



QUAD DARLINGTON TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				- No 8
Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0)	V _(BR) CEO	30	4,80	Vdc
Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0)	V(BR)CBO	40	Art 9.1	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V _{(BR)EBO}	12		Vdc
Collector Cutoff Current $(V_{CB} = 30 \text{ Vdc}, I_E = 0)$	ICBO	05 338005 F	100	nAdc
Emitter Cutoff Current (VEB = 10 Vdc, IC = 0)	IEBO	-	100	nAdc
ON CHARACTERISTICS(2)	BDMATIDA	PAD - B BRU	BR	
DC Current Gain ($I_C = 10 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$) ($I_C = 100 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$)	hFE	5000 10,000	1	0S —
Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 0.1 mAdc)	VCE(sat)	WITE TO	1.5	Vdc
Base-Emitter On Voltage (IC = 100 mAdc, VCE = 5.0 Vdc)	V _{BE(on)}		2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				40a B
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz)	fT	125		MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}		8.0	pF
Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 1.0 MHz)	C _{ibo}	75 (1	15	pF

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

NOISE CHARACTERISTICS (V_{CE} = 5.0 Vdc, T_A = 25^oC)

FIGURE 1 - NOISE VOLTAGE

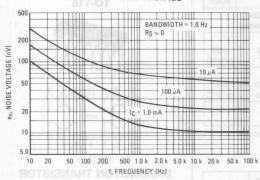


FIGURE 2 - NOISE CURRENT

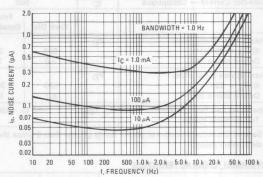


FIGURE 3 - TOTAL WIDEBAND NOISE VOLTAGE

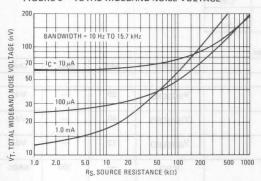
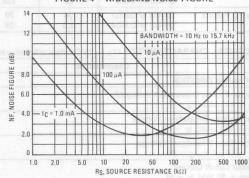


FIGURE 4 - WIDEBAND NOISE FIGURE



DYNAMIC CHARACTERISTICS

FIGURE 5 - CAPACITANCE

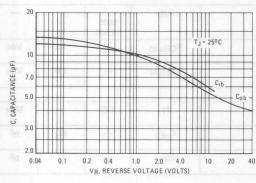
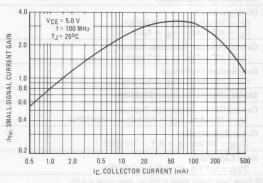


FIGURE 6 - HIGH FREQUENCY CURRENT GAIN



MPQ6501, MPQ6502 For Specifications, See MPQ6001 Data MPQ6600A1

For Specifications, See MPQ6100A Data

MAXIMUM BATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	VCEO	40		Vdc
Collector-Base Voltage	VCBO		40	Vdc
Emitter-Base Voltage	VEBO		5.0	Vdc
Collector Current — Continuous	IC	2	100	mAdc
		Each Transistor	Four Transistors Equal Power	
Total Device Dissipation @ TA = 25°C(1) Derate above 25°C	PD	500 4.0	900 7.2	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	825 6.7	2400 19.2	mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

⁽¹⁾ Second breakdown occurs at power levels greater than 3 times the power

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die Effective, 4 Die	151 52	250 139	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	34 2.0	70 26	%

MPQ6700*

CASE 646-06, STYLE 1 TO-116 TYPE B





QUAD **COMPLEMENTARY PAIR TRANSISTOR**

NPN/PNP(2) SILICON

★This is a Motorola designated preferred device.

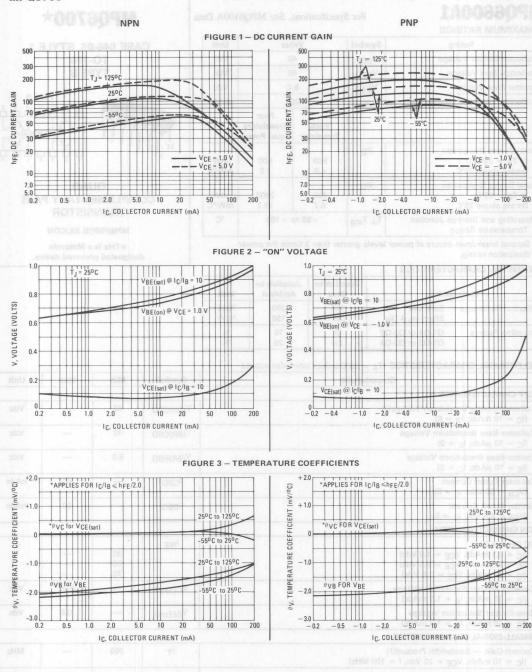
ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	and like so		Jan Lynn	
Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, I _B = 0)	V(BR)CEO	40	11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Vdc
Collector-Base Breakdown Voltage (IC = 10 μ Adc, IE = 0)	V _(BR) CBO	40	-	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	V _{(BR)EBO}	5.0	_	Vdc
Collector Cutoff Current (VCB = 30 Vdc, I _E = 0)	ІСВО	0 5/3 90 De 31/31	50	nAdc
Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0)	IEBO		50	nAdc
ON CHARACTERISTICS(1)		(9)	and A middle	3
DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc)	hFE	30 50 70	=	ENATURE OF
Collector-Emitter Saturation Voltage (IC = 10 mAdc, I _B = 1.0 mAdc)	V _{CE} (sat)		0.25	Vdc
Base-Emitter Saturation Voltage (IC = 10 mAdc, I _B = 1.0 mAdc)	V _{BE} (sat)	2 05	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS (1)	IAM THERRUS IN	16. 2011.8 678		
Current-Gain — Bandwidth Product(1) (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	fT	200	_	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	_	4.5	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz) PNP NPN	C _{ibo}	_	10 8.0	pF

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

⁽²⁾ Voltage and Current are negative for PNP Transistors.

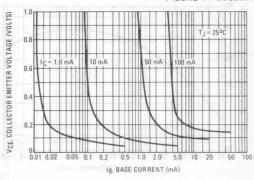
MPQ6700



NPN

PNP

FIGURE 4 - COLLECTOR SATURATION REGION



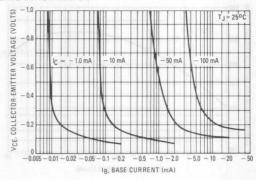
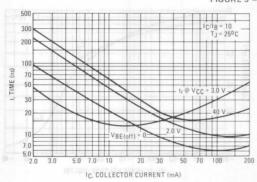


FIGURE 5 - TURN-ON TIME



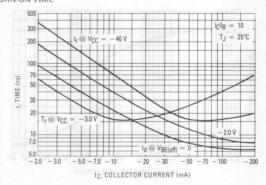
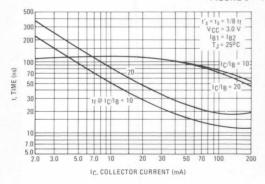
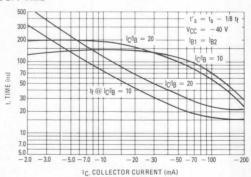


FIGURE 6 - TURN-OFF TIME

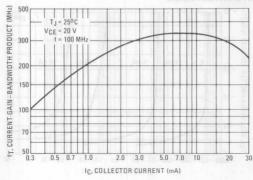




NPN

PNP

FIGURE 7 - CURRENT-GAIN - BANDWIDTH PRODUCT



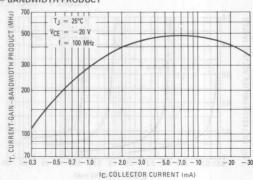
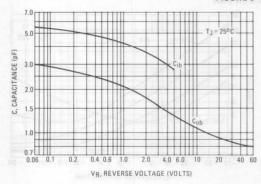
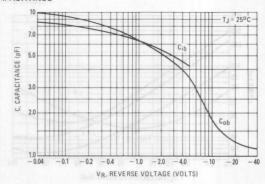


FIGURE 8 - CAPACITANCE





Rating	Symbol	Value		Unit
Collector-Emitter Voltage	er Voltage V _{CEO} 30		Vdc	
Collector-Base Voltage	VCBO	and the second	30	Vdc
Emitter-Base Voltage	V _{EBO}	4	1.0	Vdc
Collector Current — Continuous	Ic	2	00	mAdc
		Each Transistor	Four Transistors Equal Power	
Total Device Dissipation @ T _A = 25°C(1) Derate above 25°C	PD	500 4.0	900 7.2	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	825 6.7	2400 19.2	mW mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150		°C

(1) Second Breakdown occurs at power levels greater than 3 times the power dissipation rating. THERE IS NOT THE THE PROPERTY OF THE PROPE

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit	
Thermal Resistance	Each Die Effective, 4 Die	151 52	250 139	°C/W	
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	34 2.0	70 26	%	

MPQ6842

CASE 646-06, STYLE 1 TO-116 TYPE B





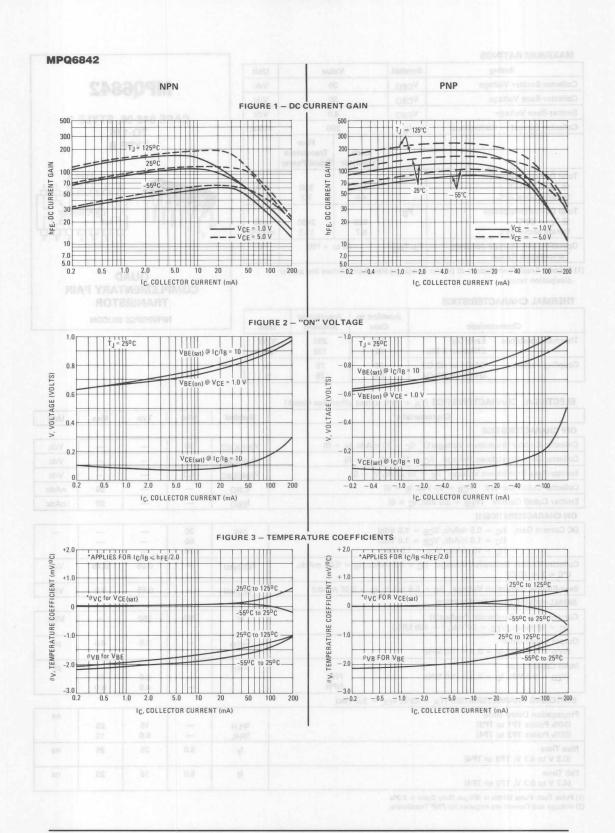
QUAD **COMPLEMENTARY PAIR TRANSISTOR**

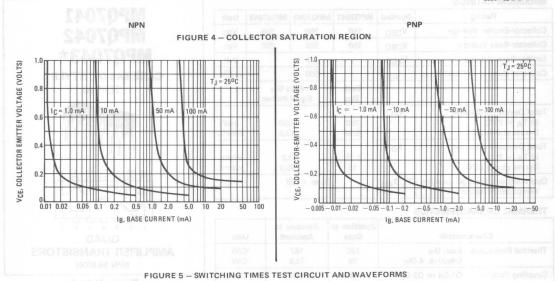
NPN/PNP(2) SILICON

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

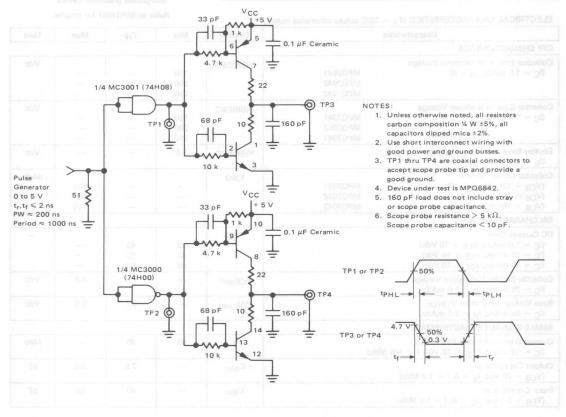
Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					N. X.
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0)	V(BR)CEO	30	_		Vdc
Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0)	V(BR)CBO	30			Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)	V(BR)EBO	4.0			Vdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0)	Ісво	0.8	10.25 10.	50	nAdd
Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0)	IEBO	Militar Inprose	0.105.71	50	nAdd
ON CHARACTERISTICS(1)					
DC Current Gain $(I_C = 0.5 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$ $(I_C = 1.0 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$ $(I_C = 10 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$	er – c hFE	30 50 70			-0.50
Collector-Emitter Saturation Voltage $(I_C = 0.5 \text{ mAdc}, I_B = 0.05 \text{ mAdc}, 0^{\circ}\text{C} \leq T \leq 70^{\circ}\text{C})$	V _{CE} (sat)		0.05	0.15	Vdc
Base-Emitter Saturation Voltage (I _C = 0.5 mAdc, I _B = 0.05 mAdc)	V _{BE(sat)}		0.65	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS		111111	(10)		40 3
Current-Gain — Bandwidth Product(1) (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	fτ	200	350		MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz	C _{obo}		3.0	4.5	pF
Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 1.0 MHz PNP NPN	C _{ibo}	=	5.0 4.0	10 8.0	pF
SWITCHING CHARACTERISTICS (T _A = 25°C, V _{CC} = 5.0 Vdc)			0.5 0.	2.9	0.2
Propagation Delay Time (50% Points TP1 to TP3) (50% Points TP2 to TP4)	tPLH tPHL	ISKRUJ KUT	15 6.0	25 15	ns
Rise Time (0.3 V to 4.7 V, TP3 or TP4)	t _r	5.0	25	35	ns
Fall Time (4.7 V to 0.3 V, TP3 or TP4)	tf	5.0	10	20	ns

- (1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (2) Voltage and Current are negative for PNP Transistors.









Rating	Symbol	MPQ7041	MPQ7042	MPQ7043	Unit
Collector-Emitter Voltage	VCEO	150	200	250	Vdc
Collector-Base Voltage	VCBO	150	200	250	Vdc
Emitter-Base Voltage	VEBO	ni ri	5.0	THE RESERVE	Vdc
Collector Current — Continuous	Ic		500	1	mAdc
		Each Die	31	ır Die I Power	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	750 5.98		700 13.6	mW mW/°C
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.25 10	10 11 50	3.2 25.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die Effective, 4 Die	100 39	167 73.5	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	46 5.0	56 10	%

MPQ7041 MPQ7042 MPQ7043*

CASE 646-06, STYLE 1 TO-116



NPN 1 2 3 4 5 6 7

AMPLIFIER TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

Refer to MPQ7051 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit	
OFF CHARACTERISTICS	Simple States	T TEL	V-10-			
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	MPQ7041 MPQ7042 MPQ7043	V(BR)CEO	150 200 250	MC3001 (24)	Mr.	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	MPQ7041 MPQ7042 MPQ7043	V(BR)CBO	150 200 250		Ξ	Vdc
Emitter-Base Breakdown Voltage (IE = 100 μ Adc, IC = 0)		V _{(BR)EBO}	5.0	-	_	Vdc
Collector Cutoff Current (V _{CB} = 120 Vdc, I _E = 0) (V _{CB} = 150 Vdc, I _E = 0) (V _{CB} = 180 Vdc, I _E = 0)	MPQ7041 MPQ7042 MPQ7043	ІСВО	=		100 100 100	nAdc
ON CHARACTERISTICS		Parl The			tand en O	erious = W
DC Current Gain	Simple Carpois	hFE	25 40 40	45 60 80	Ξ	-
Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc)		VCE(sat)		0.3	0.5	Vdc
Base-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc)	Aw der	V _{BE(sat)}	10 T 6	0.7	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS		Lat. I	hil			
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 M	Hz)	fT	50	80		MHz
Output Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}	-	2.5	5.0	pF
Input Capacitance (VEB = 3.0 Vdc, I _C = 0, f = 1.0 MHz)		C _{ibo}	-	40	50	pF

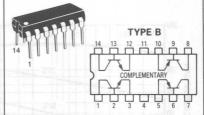
Rating	Symbol	Value		Unit
Collector-Emitter Voltage	VCEO	15	150	
Collector-Base Voltage	V _{CBO}	15	50	Vdc
Emitter-Base Voltage	V _{EBO}	5.	.0	Vdc
Collector Current — Continuous	Ic	50	00	mAdc
1381 = 1	4 I Vior	Each Die	Four Die Equal Power	HUDE
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	750 5.98	1700 13.6	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.25 10	3.2 25.6	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit	
Thermal Resistance	Each Die Effective, 4 Die	100 39	167 73.5	°C/W	
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	46 5.0	56 10	%	

MPQ7051*

CASE 646-06, TYPE B TO-116



QUAD COMPLEMENTARY PAIR TRANSISTOR

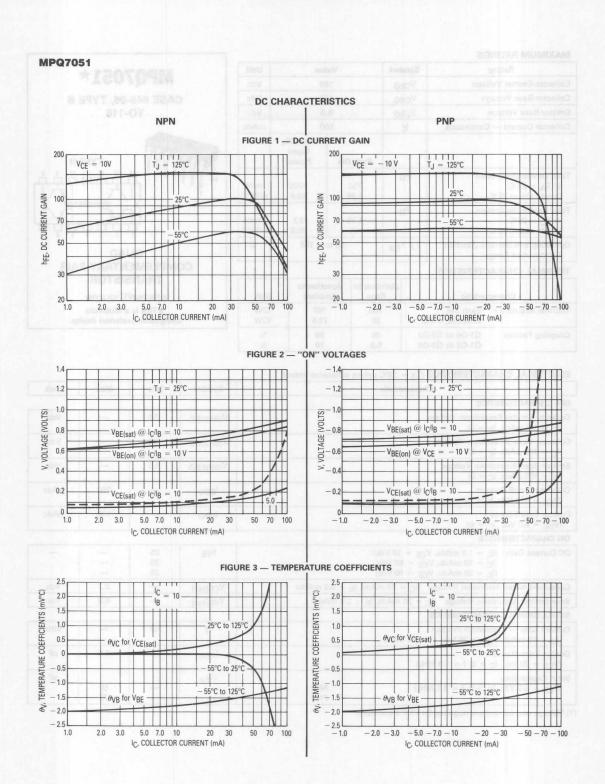
NPN/PNP⁽¹⁾ SILICON

★This is a Motorola
designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	8 10 1	V(BR)CEO	150		Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)		V(BR)CBO	150	JANU TO THE PERSON NAMED IN COLUMN T	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)		V(BR)EBO	5.0		Vdc
Collector Cutoff Current (V _{CB} = 120 Vdc, I _E = 0)	2.0	Ісво	1 - 1/01 0	250	nAdc
Emitter Cutoff Current (VBE = 3.0 Vdc, I _C = 0)	IEBO	1 97 08	100	nAdc	
ON CHARACTERISTICS		PROCESSION	mar columns ()		
DC Current Gain $(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ $(I_C = 30 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$	TEMPERATURE CUEFFIC	h _{FE}	25 35 25	=	-
Collector-Emitter Saturation Voltage (I _C = 20 mAc	lc, I _B = 2.0 mAdc)	V _{CE} (sat)	7	0.7	Vdc
Base-Emitter Saturation Voltage (I _C = 20 mAdc, I _E	3 = 2.0 mAdc)	V _{BE(sat)}	-	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	to 2	fT	50	ot such	MHz
Output Capacitance (V _{CB} = 20 Vdc, I _C = 0, f = 1.0 MHz)		C _{obo}		6.0	pF
Input Capacitance (V _{EB} = 3.0 Vdc, I _C = 0, f = 1.0 MHz)	NPN PNP	C _{ibo}		50 75	pF

⁽¹⁾ Voltage and current are negative for PNP transistors.



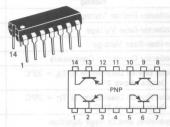
Rating	Symbol	MPQ70	91 MPQ7093	Unit		
Collector-Emitter Voltage	VCEO	- 150	-250	Vdc		
Collector-Base Voltage	V _{CBO}	- 150	-250	Vdc		
Emitter-Base Voltage	VEBO	27940	-5.0	Vdc		
Collector Current — Continuous	lc	-500		C -500		mAdc
(Minus 17 26-41		Each Die	Four Die Equal Power			
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	750 5.98	1700 13.6	mW mW/°C		
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.25 10	3.2 25.6	Watts mW/°C		
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C		

THERMAL CHARACTERISTICS

Charac	eteristic	Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die Effective, 4 Die	100 39	167 73.5	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	46 5.0	56 10	%

MPQ7091 MPQ7093*

CASE 646-06, STYLE 1 TO-116



QUAD AMPLIFIER TRANSISTORS

PNP SILICON

★This is a Motorola designated preferred device.

Refer to MPQ7051 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit	
OFF CHARACTERISTICS	Vigeropo			(%)e	autoV myub	Assert Break	-torcello3
Collector-Emitter Breakdown Voltage ($I_C = -1.0 \text{ mAdc}, I_B = 0$)	neneau/	MPQ7091 MPQ7093	V _(BR) CEO	- 150 - 250	= 0) egshav nvv	15 mAdc, Ig 8eer o raekde 10 u st ac Ig	Vdc
Collector-Base Breakdown Voltage ($I_C = -100 \mu Adc, I_E = 0$)		MPQ7091 MPQ7093	V(BR)CBO	- 150 - 250	epatieV n		Vdc
Emitter-Base Breakdown Voltage ($I_E = -100 \mu Adc, I_C = 0$)	0801		V _{(BR)EBO}	-5.0	70 =	1 Tac, 1g	Vdc
Collector Cutoff Current (V _{CB} = -120 Vdc, I _E = 0)		MPQ7091 MPQ7093	ІСВО	_	(0 =	-250 -250	nAdc
Emitter Cutoff Current (VEB = -3.0 Vdc, I _C = 0)	31/1		IEBO	- (687	at.o 3	-100	nAdc
ON CHARACTERISTICS	VGE(sar)			/	mion Voltage	nume i primi	Colluctor-
	VBE(sat)		hFE	25 35 25	40 55 50	id n. Vdc, ig ser S ripratier 12. r. Ade, ig	- 30 - 30 - 30
Collector-Emitter Saturation Voltage (I	C = -20 n	nAdc, I _B = -2.0 mAdc)	V _{CE(sat)}	_	-0.3	-0.5	Vdc
Base-Emitter Saturation Voltage (IC =	- 20 mAd	c, I _B = -2.0 mAdc)	V _{BE(sat)}	_	-0.7	-0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS	00.			. (nbV it a - ge	Maskar 1 0 F	- (1c =
Current-Gain — Bandwidth Product $(I_C = -10 \text{ mAdc}, V_{CE} = -20 \text{ Vdc},$	f = 100 MH	Hz)	fT	50	70	eoms joe u	MHz
Output Capacitance $(V_{CB} = -20 \text{ Vdc}, I_E = 0, f = 1.0 \text{ M})$	Hz)		C _{obo}	2,0% = 2.0%	3.0	5.0	pF
Input Capacitance (VEB = -3.0 Vdc, I _C = 0, f = 1.0 M	1Hz)		C _{ibo}	_	60	75	pF

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-35	Vdc
Collector-Base Voltage	VCBO	-40	Vdc
Emitter-Base Voltage	VEBO	-25	Vdc
Collector Current — Continuous	Ic	- 150	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	I Inia
Characteristic	Symbol	IVIAX	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	200	°C/W
Thermal Resistance, Junction to Case	Reic	83.3	°C/W

MPS404A*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



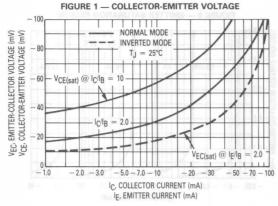
CHOPPER TRANSISTOR PNP SILICON

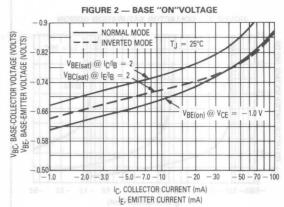
★This is a Motorola designated preferred device.

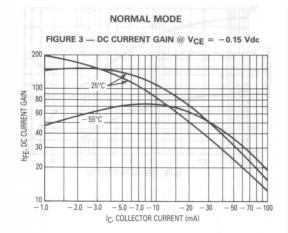
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

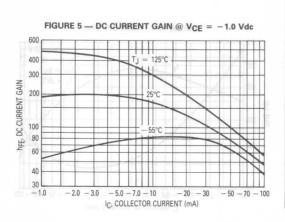
C	haracterist	tic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	Min	1edmy8		olfules	Charact		
Collector-Emitter Breakdown Voltage (I _C = -10 mAdc, I _B = 0)	(2)	Озалав)У		V(BR)CEO	-35	AGTS <u>se</u> STACE mitter By and	Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc, I_E = 0$)	- 150 250		PQ7093	V _(BR) CBO	-40	i.0 ro <u>Ad</u> e, ig	Vdc
Emitter-Base Breakdown Voltage (I _E = -10μ Adc, I _C = 0)	081-	V(BR))CBO	1807091	V _{(BR)EBO}	-25	obvisar9 nas gr _u abAu, 00	Vdc
Collector Cutoff Current (VCB = -10 Vdc, IE = 0)	0.3-	O83(88)V	EGGLE	ICBO	Voitage	-100	nAdd
Emitter Cutoff Current (VBE = -10 Vdc, IC = 0)		080		IEBO	-	-100	nAdc
ON CHARACTERISTICS			2000 CM	ina Ma	No.	Bethes Aze	804
DC Current Gain (I _C = -12 mAdc, V _{CE} = -0.15 V	dc)	leso		hFE	30	400	nitter Cu
Collector-Emitter Saturation Voltage $(I_C = -12 \text{ mAdc}, I_B = -0.4 \text{ mAd})$ $(I_C = -24 \text{ mAdc}, I_B = -1.0 \text{ mAdd})$		344		VCE(sat)	=	-0.15 -0.20	Vdc
Base-Emitter Saturation Voltage $(I_C = -12 \text{ mAdc}, I_B = -0.4 \text{ mAd})$ $(I_C = -24 \text{ mAdc}, I_B = -1.0 \text{ mAdd})$				V _{BE} (sat)	bV 0(= bV 0(- =	-0.85 -1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS		(165)EDY	TOURING I - Brade	Part US 7 = QH	ARBINA MO	SERVICE ISTORY	or resolution
Common-Base Cutoff Frequency (I _C = -1.0 mAdc, V _{CB} = 6.0 Vdc)		VER (SAI)) Johnson d. x. — B	f _{ob}	4.0	MAL CHARA	MHz
Output Capacitance (VCB = -6.0 Vdc, I _E = 0, f = 1.0	MU-A	T)		C _{obo}	ith Pindust = -20 Vd	20	pF

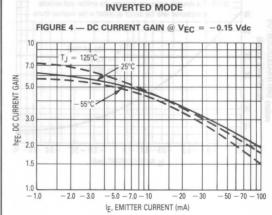
MPS404A

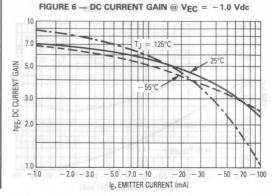




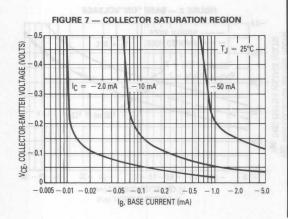


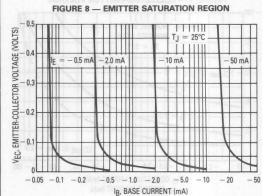






MPS404A







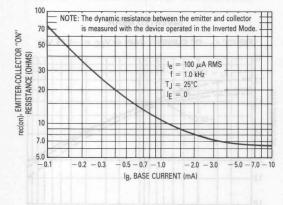


FIGURE 10 — CAPACITANCE

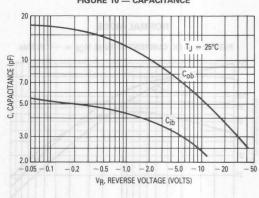


FIGURE 11 — TURN-ON TIME

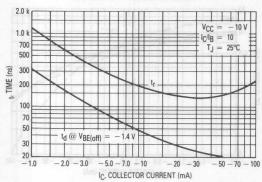
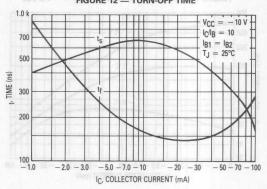
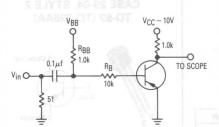


FIGURE 12 — TURN-OFF TIME



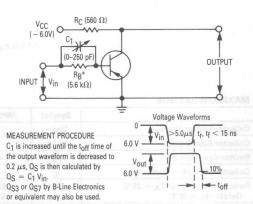




ENCY	V _{in} (Volts)	V _{BB} (Volts)
ton, td and tr	- 12	+ 1.4
toff, ts and tf	+ 20.6	- 11.6

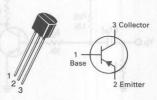
Voltages and resistor values shown are for $I_C=10$ mA, $I_C/I_B=10$ and $I_{B1}=I_{B2}$. Resistor values changed to obtain curves in Figures 11 and 12.

FIGURE 14 — STORED BASE CHARGE TEST CIRCUIT



MPS536

CASE 29-04, STYLE 2 TO-92 (TO-226AA)



HIGH FREQUENCY TRANSISTOR

PNP SILICON

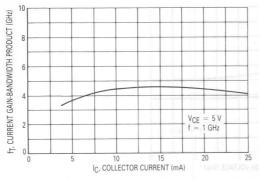
MAXIMUM RATINGS

Rating	Symbol	MPS536	Unit	
Collector-Emitter Voltage	VCEO	-10	Vdc	
Collector-Base Voltage	V _{CBO}	- 15	Vdc	
Emitter-Base Voltage	VEBO	-4.5	Vdc	
Collector Current — Continuous	lc	-30	mA	
Power Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C	
Storage Temperature	T _{stg}	-65 to +150	°C	

*Free air

ELECTRICAL CHARACTERISTICS (T_C = 25°C *For both package types unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = -2.0$ mA, $I_B = 0$) V(BR)CEO	-10	_	_	Vdc
Collector-Base Breakdown Voltage ($I_C = -100 \mu A$, $I_E = 0$)	V(BR)CBO	-15	_	-	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu A$, $I_C = 0$)	V(BR)EBO	-4.5	_		Vdc
Collector Cutoff Current (V _{CB} = −10 Vdc, I _E = 0)	ICBO		_	-10	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = -20$ mA, $V_{CE} = -5.0$ V)	hFE	20	_	200	_
DYNAMIC CHARACTERISTICS					1-311
Current-Gain — Bandwidth Product (I _C = -20 mAdc, V _{CE} = -5.0 Vdc, f = 1.0 GHz)	fT	-	4.5	-	GHz
Collector-Base Capacitance (V _{CB} = -5.0 Vdc, I _F = 0, f = 1.0 MHz)	C _{cb}	-	0.8	1.2	pF
FUNCTIONAL TESTS					
Gain @ Noise Figure $(I_C = -10 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc})$ $f = 500 \text{ MHz}$ $f = 1.0 \text{ GHz}$	GNF		14 8.0	- 1	dB
Noise Figure	NF		0.0		dB
$(I_C = -10 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc}$ f = 500 MHz			4.5	_	u.b
f = 1.0 GHz		-	6.0		



MAXIMUM AVAILABLE GAIN (dB) GAmax, $V_{CE} = 5 V$ $I_{C} = 20 \text{ mA}$ 0.5 f, FREQUENCY (GHz) 0.3

versus Collector Current

Figure 1. Current Gain-Bandwidth Product Figure 2. Maximum Available Gain (GAmax) versus Frequency

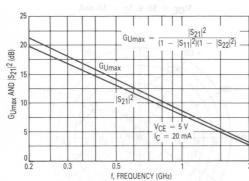


Figure 3. Maximum Unilateral Gain (GUmax) and Insertion Gain (|S₂₁|²) versus Frequency

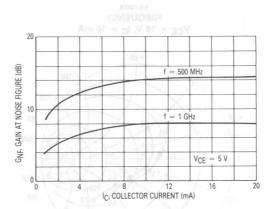
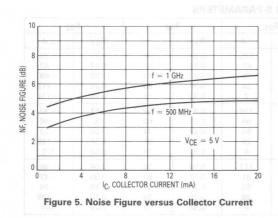
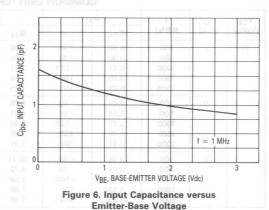


Figure 4. Gain at Noise Figure versus **Collector Current**





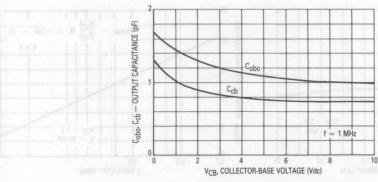
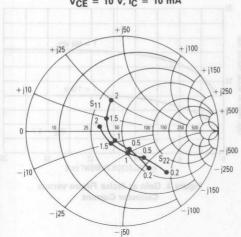


Figure 7. Output Capacitance versus

Collector-Base Voltage

INPUT/OUTPUT REFLECTION COEFFICIENT

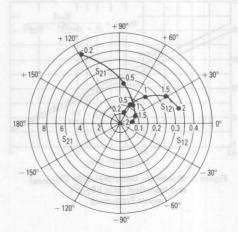
versus
FREQUENCY
VCE = 10 V, IC = 10 mA



FORWARD/REVERSE TRANSMISSION COEFFICIENTS

versus FREQUENCY

VCE = 10 V, IC = 10 mA



COMMON EMITTER S-PARAMETERS

VCE	Ic	f	S	11	S	21	S ₁	2	S	22
(Volts)	(mA)	(MHz)	S ₁₁	∠ φ	S ₂₁	∠ φ	S ₁₂	∠ φ	S ₂₂	∠ φ
10	5	200	0.60	- 43	6.60	125	0.07	68	0.71	-35
		500	0.30	-60	3.64	87	0.14	57	0.47	-43
		1000	0.17	-103	2.11	56	0.22	43	0.32	- 69
-		1500	0.15	156	1.70	28	0.30	28	0.22	-112
		2000	0.28	110	1.29	2	0.33	13	0.25	- 174
	10	200	0.48	- 52	8.78	118	0.06	69	0.62	-42
-		500	0.21	-66	4.31	84	0.12	60	0.37	-46
		1000	0.12	- 122	2.40	54	0.20	47	0.24	-73
		1500	0.18	138	1.90	29	0.29	31	0.16	- 126
1 3	HM 1 = 1	2000	0.32	104	1.41	4	0.33	16	0.23	170
	20	200	0.38	- 59	10.21	112	0.06	70	0.54	-46
		500	0.14	-76	4.72	81	0.12	63	0.30	-47
	(bbV	1000	0.11	- 144	2.58	53	0.20	49	0.19	-74
		1500	0.22	132	1.99	28	0.29	34	0.12	- 139
	STICIES	2000	0.35	103	1.46	4	0.33	19	0.22	161

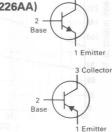
Rating a TASARAGO	Symbol	MPS650 MPS750	MPS651 MPS751	Unit	
Collector-Emitter Voltage	VCE	40 60		Vdc	
Collector-Base Voltage	VCB	60	80	Vdc	
Emitter-Base Voltage	VEB	5	.0	Vdc	
Collector Current — Continuous	Ic	2.0		Adc	
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C	
Total Power Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watt mW/°C	
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C	

THERMAL CHARACTERISTICS

Characteristic (1977)	istic Symbol Max		Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

MPS650, MPS651* PNP(3) MPS750, MPS751*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



3 Collector

AMPLIFIER TRANSISTORS

★These are Motorola designated preferred devices.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

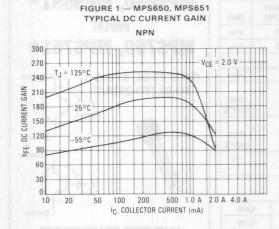
Chara	cteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS			MAN.		
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0)	MPS650, MPS750 MPS651, MPS751	V(BR)CEO	40 60		Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	MPS650, MPS750 MPS651, MPS751	V(BR)CBO	60 80	_	Vdc
Emitter-Base Breakdown Voltage (I _C = 0, I _E = 10 μAdc)	31 - 12	V _{(BR)EBO}	5.0	-	Vdc
Collector Cutoff Current $(V_{CB} = 60 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = 80 \text{ Vdc}, I_{E} = 0)$	MPS650, MPS750 MPS651, MPS751	ІСВО	16V	0.1 0.1	μAdc
Emitter Cutoff Current (V _{EB} = 4.0 V, I _C = 0)	10-	I _{EBO}		0.1	μAdc
ON CHARACTERISTICS(1)	80 - 02- A B B	A 9.5 A P ? No	d ONE		18
DC Current Gain ($I_C = 50 \text{ mA}, V_{CE} = 2.0 \text{ V}$) ($I_C = 500 \text{ mA}, V_{CE} = 2.0 \text{ V}$) ($I_C = 1.0 \text{ A}, V_{CE} = 2.0 \text{ V}$) ($I_C = 2.0 \text{ A}, V_{CE} = 2.0 \text{ V}$)		hFE	75 75 75 40	=	_
Collector-Emitter Saturation Voltage (I _C = 2.0 A, I _B = 200 mA) (I _C = 1.0 A, I _B = 100 mA)	VCE(sat)	BBS9M — TARUTAS Ven	0.5 0.3	Vdc	
Base-Emitter On Voltage (I _C = 1.0 A, V _{CE} = 2.0 V)		V _{BE(on)}		1.0	Vdc
Base-Emitter Saturation Voltage (I _C = 1.0 A, I _B = 100 mA)	N - 01	V _{BE} (sat)		1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS	- 1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1		1-11		1100
Current-Gain — Bandwidth Product(2) (I _C = 50 mAdc, V _{CE} = 5.0 Vdc, f = 10	00 MHz)	fT	75	1 -	MHz

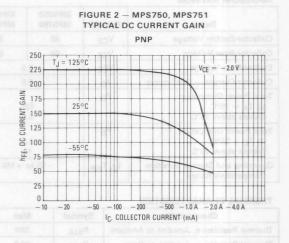
⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle = 2.0%.

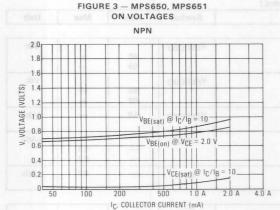
⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

⁽³⁾ Voltage and current are negative for PNP transistors.

NPN MPS650 MPS651 PNP MPS750 MPS751







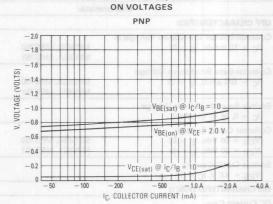
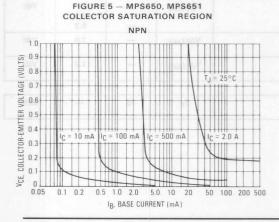
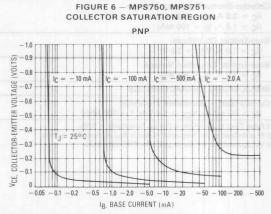


FIGURE 4 - MPS750, MPS751

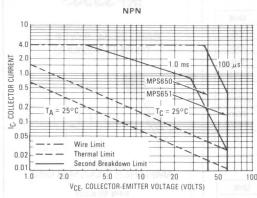


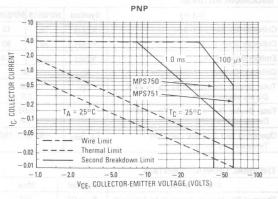


NPN MPS650 MPS651 PNP MPS750 MPS751









Rating	Symbol	MPS918	MPS3563	Unit
Collector-Emitter Voltage	VCEO	15	12	Vdc
Collector-Base Voltage	VCBO	30	30	Vdc
Emitter-Base Voltage	VEBO	3.0	2.0	Vdc
Collector Current — Continuous	Ic	50		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	0.85 6.8		Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

		The state of the s	44 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	147	°C/W

MPS918* **MPS3563**

CASE 29-04, STYLE 1 TO-92 (TO-226AA)





AMPLIFIER TRANSISTORS

NPN SILICON ★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (IC = 3.0 mAdc, I _B = 0)	MPS918 MPS3563	V(BR)CEO	15 12	_	Vdc
Collector-Base Breakdown Voltage (IC = 1.0 μ Adc, IE = 0) (IC = 100 μ Adc, IE = 0)	MPS918 MPS3563	V(BR)CBO	30 30	=	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	MPS918 MPS3563	V(BR)EBO	3.0 2.0	=	Vdc
Collector Cutoff Current (V _{CB} = 15 Vdc, I _E = 0)	MPS918 MPS3563	ІСВО	=	10 50	nAdc
ON CHARACTERISTICS					
DC Current Gain(2) (I _C = 3.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 8.0 mAdc, V _{CE} = 10 Vdc)	MPS918 MPS3563	hFE	20 20	 200	= -
Collector-Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}$, $I_B = 1.0 \text{ mAdc}$)	MPS918	VCE(sat)	-	0.4	Vdc
Base-Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}$, $I_B = 1.0 \text{ mAdc}$)	MPS918	V _{BE(sat)}		1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) (I _C = 8.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	MPS918 MPS3563	fT	600 600	_ 1500	MHz
Output Capacitance $(V_{CB} = 0 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz})$ $(V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz})$ $(V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz})$	MPS918 MPS918 MPS3563	C _{obo}	Ξ	3.0 1.7 1.7	pF
Input Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	MPS918	C _{ibo}		2.0	pF
Small-Signal Current Gain ($I_C = 8.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	MPS3563	h _{fe}	20	250	-
Noise Figure (I _C = 1.0 mAdc, V_{CE} = 6.0 Vdc, R_S = 400 ohms, f = 60 MHz)	MPS918	NF	_	6.0	dB

⁽¹⁾ RøJA is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width \leqslant 300 μ s, Duty Cycle \leqslant 1.0%.

Characteristic				ol Min	Max	Unit	
FUNCTIONAL TEST					SEMITATIV	UNIXAM	
Common-Emitter Amplifier Power Gain (I _C = 6.0 mAdc, V _{CB} = 12 Vdc, f = 200 MHz) (I _C = 8.0 mAdc, V _{CE} = 10 Vdc, f = 200 MHz)	Vde Vde		MPS918 MPS3563	OBOV	15 14	gnib-Fi agarlo Vi je tilo apa NoV ose	dB Francisco
$(G_{fd} + G_{re} < -20 \text{ dB})$ Power Output	Velc	0.8 0.8	Pout	30	aliego, a	mW	
$(I_C = 8.0 \text{ mAdc}, V_{CB} = 15 \text{ Vdc}, f = 500 \text{ MHz})$	ab/km	MPS918	D)	BUQUIT	inent Corts	Collector C	
Oscillator Collector Efficiency (I _C = 8.0 mAdc, V_{CB} = 15 Vdc, P_{out} = 30 mW,	f = 500 MHz)	MPS918	G ^q η	25	s O st ill stion 6 m n 25°C	%	
es and	Watts	4.4	ad	ce Dissipation @ Tg = 25°C			

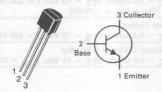
Rating	Symbol	MPS2222	MPS2222A	Unit
Collector-Emitter Voltage	VCEO	30	40	Vdc
Collector-Base Voltage	VCBO	60	75	Vdc
Emitter-Base Voltage	VEBO	5.0	6.0	Vdc
Collector Current — Continuous	Ic	86	600	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

MPS2222,A*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

★MPS2222A is a Motorola designated preferred device.

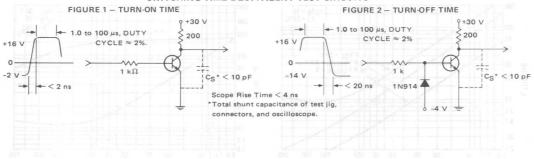
ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	MPS2222 MPS2222A	V(BR)CEO	30 40	=	Vdc
Collector-Base Breakdown Voltage (IC = 10 μ Adc, IE = 0)	MPS2222 MPS2222A	V(BR)CBO	60 75	=	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	MPS2222 MPS2222A	V(BR)EBO	5.0 6.0	=	Vdc
Collector Cutoff Current (V _{CE} = 60 Vdc, V _{EB(off)} = 3.0 Vdc)	MPS2222A	ICEX	_	10	nAdc
Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0) (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 50 Vdc, I _E = 0, T _A = 125°C) (V _{CB} = 50 Vdc, I _E = 0, T _A = 125°C)	MPS2222 MPS2222A MPS2222 MPS2222A	ICBO	Ξ	0.01 0.01 10 10	μAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0)	MPS2222A	IEBO	-	100	nAdc
Base Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc)	MPS2222A	IBL	-	20	nAdc
ON CHARACTERISTICS					
DC Current Gain $ \begin{aligned} &(I_C = 0.1 \text{ mAdc, V}_{CE} = 10 \text{ Vdc}) \\ &(I_C = 1.0 \text{ mAdc, V}_{CE} = 10 \text{ Vdc}) \\ &(I_C = 10 \text{ mAdc, V}_{CE} = 10 \text{ Vdc}) \\ &(I_C = 10 \text{ mAdc, V}_{CE} = 10 \text{ Vdc, T}_{A} = -55^{\circ}\text{C}) \\ &(I_C = 150 \text{ mAdc, V}_{CE} = 10 \text{ Vdc})(1) \\ &(I_C = 150 \text{ mAdc, V}_{CE} = 1.0 \text{ Vdc})(1) \\ &(I_C = 500 \text{ mAdc, V}_{CE} = 10 \text{ Vdc})(1) \end{aligned} $	MPS2222A only MPS2222 MPS2222A	hFE	35 50 75 35 100 50 30 40	300	
Collector-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc)	MPS2222 MPS2222A	VCE(sat)	=	0.4 0.3	Vdc
$(I_C = 500 \text{ mAdc}, I_B = 50 \text{ mAdc})$	MPS2222 MPS2222A		=	1.6 1.0	

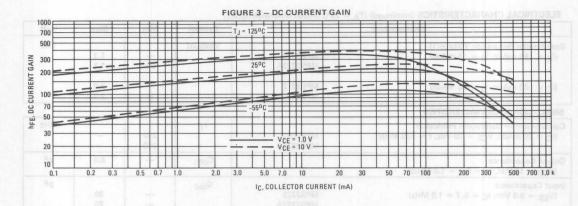
ELECTRICAL CHARACTERISTICS (continued) ($T_A = 25^{\circ}C$ unless otherwise noted.)

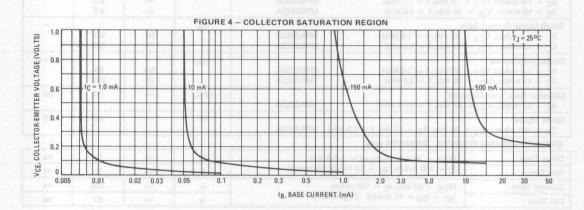
Characteristic			Symbol	Min	Max	Unit
Base-Emitter Saturation Voltage(1) ($I_C = 150 \text{ mAdc}$, $I_B = 15 \text{ mAdc}$)		MPS2222 MPS2222A	V _{BE} (sat)	 0.6	1.3 1.2	Vdc
$(I_C = 500 \text{ mAdc}, I_B = 50 \text{ mAdc})$		MPS2222 MPS2222A			2.6 2.0	= = 001
SMALL-SIGNAL CHARACTERISTIC	S					107
Current-Gain — Bandwidth Produc (I _C = 20 mAdc, V _{CE} = 20 Vdc, f		MPS2222 MPS2222A	fT	250 300		MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0	VIHz)	DI RE DE	C _{obo}	1 - 1	8.0	pF
Input Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0		MPS2222 MPS2222A	C _{ibo}	_	30 25	pF
Input Impedance $(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, (I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, 10 M$		MPS2222A MPS2222A	h _{ie}	2.0 0.25	8.0 1.25	kΩ
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, (I _C = 10 mAdc, V _{CE} = 10 Vdc,		MPS2222A MPS2222A	h _{re}	_	8.0 4.0	X 10 ⁻⁴
Small-Signal Current Gain ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, ($I_C = 10 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, the state of the		MPS2222A MPS2222A	h _{fe}	50 75	300 375	
Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)		MPS2222A MPS2222A	h _{oe}	5.0 25	35 200	μmhos
Collector Base Time Constant (I _F = 20 mAdc, V _{CB} = 20 Vdc, f = 31.8 MHz)		MPS2222A	rb′C _C		150	ps
Noise Figure (I _C = 100 μ Adc, V _{CF} = 10 Vdc, R _S = 1.0 k Ω , f = 1.0 kHz)		Hz) MPS2222A	NF		4.0	dB
SWITCHING CHARACTERISTICS	MPS2222A only					- en 8
	$(V_{CC} = 30 \text{ Vdc}, V_{BE(off)} = -0.5 \text{ Vdc},$		td	-	10	ns
Rise Time I _C = 1	$_{0}$ mAdc, $I_{B1} = 15$ mAd	dc) (Figure 1)	tr		25	ns
	30 Vdc, I _C = 150 mAd		t _S	20.8 29.0	225	ns
Fall Time IB1 =	$B_2 = 15 \text{ mAdc}$ (Figur	e 2)	tf	_	60	ns

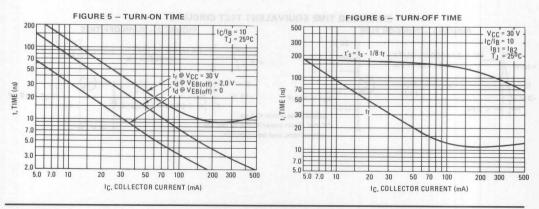
3M 140 MBUT SWITCHING TIME EQUIVALENT TEST CIRCUITS TWO MBUT - 2 3 BUDGS



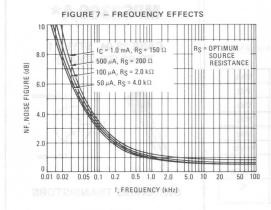
⁽¹⁾ Pulse Test: Pulse Width $\leq 300~\mu s$, Duty Cycle $\leq 2.0\%$. (2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

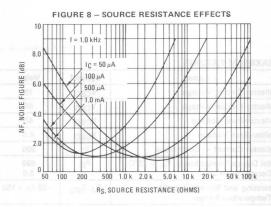


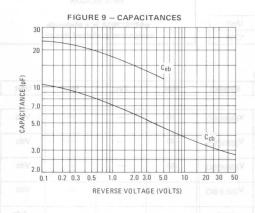


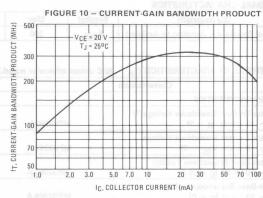


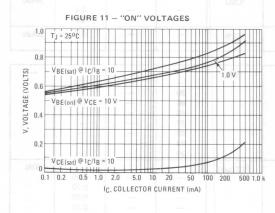
MPS2222, A

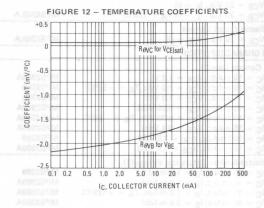












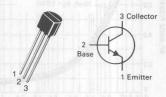
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	15	Vdc
Collector-Emitter Voltage	VCES	40	Vdc
Collector-Base Voltage	VCBO	40	Vdc
Emitter-Base Voltage	VEBO	4.5	Vdc
Collector Current — Continuous	lc	200	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

THE HUAL CHARACTERIO HOC					
Characteristic	Symbol	Max	Unit		
Thermal Resistance, Junction to Ambient	RAIA	200	°C/W		

MPS2369,A*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



SWITCHING TRANSISTORS

NPN SILICON

★MPS2369A is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	B *** B	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						100
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0)	MPS2369A	V(BR)CEO	15		-	Vdc
Collector-Emitter Breakdown Voltage (I _C = 10 μAdc, V _{BE} = 0)	MPS2369,A	V(BR)CES	40	-		Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu Adc, I_E = 0$)	MPS2369,A	V(BR)CBO	40	1 - H		Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)	MPS2369,A	V(BR)EBO	4.5	ATJER T ZRINJE	-	Vdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I_E = 0) (V _{CB} = 20 Vdc, I_E = 0, T_A = 125°C)	MPS2369,A	ICBO	ADDAT:	0.0	0.4	μAdc
Collector Cutoff Current (V _{CE} = 20 Vdc, V _{BE} = 0)	MPS2369,A	ICES			0.4	μAdc
ON CHARACTERISTICS		HIPAG				3.0
DC Current Gain(1)	MPS2369A MPS2369 MPS2369	hFE		= 10	120 — 120	Ver (Agric)
(I _C = 10 mAdc, V _{CE} = 0.35 Vdc) (I _C = 10 mAdc, V _{CE} = 0.35 Vdc, T _A = -55°C) (I _C = 30 mAdc, V _{CE} = 0.4 Vdc) (I _C = 100 mAdc, V _{CE} = 2.0 Vdc) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc)	MPS2369A MPS2369A MPS2369A MPS2369 MPS2369A		40 20 30 20 20			1.4. S
Collector-Emitter Saturation Voltage(1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 10 mAdc, I _B = 1.0 mAdc, T _A = +125°C) (I _C = 30 mAdc, I _B = 3.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc)	MPS2369 MPS2369A MPS2369A MPS2369A MPS2369A	VCE(sat)	10 - 45 14m2 - 4	0 - 93 8013-103.3	0.25 0.20 0.30 0.25 0.50	Vdc
$\begin{array}{lll} \text{Base-Emitter Saturation Voltage(1)} \\ \text{(I}_{\text{C}} &= 10 \text{ mAdc, I}_{\text{B}} &= 1.0 \text{ mAdc)} \\ \text{(I}_{\text{C}} &= 10 \text{ mAdc, I}_{\text{B}} &= 1.0 \text{ mAdc, T}_{\text{A}} &= +125^{\circ}\text{C)} \\ \text{(I}_{\text{C}} &= 10 \text{ mAdc, I}_{\text{B}} &= 1.0 \text{ mAdc, T}_{\text{A}} &= -55^{\circ}\text{C)} \\ \text{(I}_{\text{C}} &= 30 \text{ mAdc, I}_{\text{B}} &= 3.0 \text{ mAdc)} \\ \text{(I}_{\text{C}} &= 100 \text{ mAdc, I}_{\text{B}} &= 10 \text{ mAdc)} \end{array}$	MPS2369 MPS2369A MPS2369A MPS2369A MPS2369A	V _{BE} (sat)	0.7 0.5 —	= = =	0.85 — 1.02 1.15 1.60	Vdc

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

ELECTRICAL CHARACTERISTICS (Continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
SMALL-SIGNAL CHARACTERISTICS	rink Axosoza	En 1 1065298	Symulati 1		151 tg/)	
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	MPS2369,A	C _{obo}	VOEO	_	4.0	pF
Small Signal Current Gain (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	MPS2369,A	h _{fe}	5.0	_	v. 38 91 V	mitter-Base
SWITCHING CHARACTERISTICS	pbAm	1005-	21	shahui	mad - tunt	ollector Curr
Storage Time $(I_{B1} = I_{B2} = I_{C} = 10 \text{ mAdc})$ (Figure 3)	MPS2369,A	asa t _s		5.0	13	ns
Turn-On Time $(V_{CC}=3.0\ \text{Vdc},\ I_{C}=10\ \text{mAdc},\ I_{B1}=3.0\ \text{mAdc},\ (Figure 1)$	c) MPS2369,A	t _{on}	a ₃	8.0	12	ns Stal David
Turn-Off Time ($V_{CC} = 3.0 \text{ Vdc}$, $I_{C} = 10 \text{ mAdc}$, $I_{B1} = 3.0 \text{ mAdc}$) $I_{B2} = 1.5 \text{ mAdc}$) (Figure 2)		toff	gmT LT	10 notion	18	ns c gmanac

FIGURE 1 — ton CIRCUIT

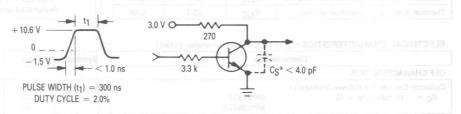


FIGURE 2 — toff CIRCUIT

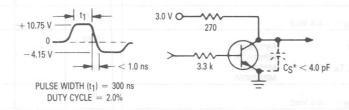
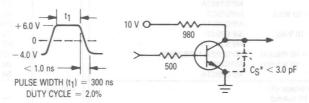


FIGURE 3 — STORAGE TEST CIRCUIT



*TOTAL SHUNT CAPACITANCE OF TEST JIG AND CONNECTORS.

Rating	Symbol	MPS2907	MPS2907A	Unit
Collector-Emitter Voltage	VCEO	-40	-60	Vdc
Collector-Base Voltage	VCBO		60	Vdc
Emitter-Base Voltage	VEBO	· · · · · · · · · · · · · · · · · · ·	-5.0	
Collector Current — Continuous	Ic	-600		mAdc
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-500 t	to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W

MPS2907,A*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)





GENERAL PURPOSE TRANSISTORS

PNP SILICON

★MPS2907A is a Motorola designated preferred device.

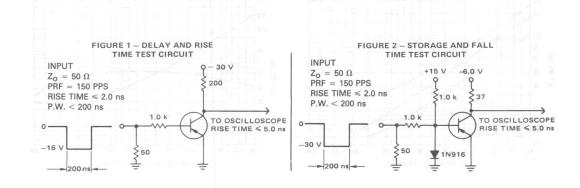
Character	istic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	YES BOT	10			
Collector-Emitter Breakdown Voltage(1) $(I_C = -10 \text{ mAdc}, I_B = 0)$	MPS2907 MPS2907A	V(BR)CEO	-40 -60	Ξ	Vdc
Collector-Base Breakdown Voltage (I _C = -10μ Adc, I _E = 0)		V _{(BR)CBO}	-60	-	Vdc
Emitter-Base Breakdown Voltage (I _E = -10μ Adc, I _C = 0)	PIGDIE 2 TOR GREDIT	V(BR)EBO	-5.0	-	Vdc
Collector Cutoff Current (VCE = -30 Vdc, VEB(off) = -0.5 Vdc)	80 V O VOS	ICEX	- 10.75 V	-50	nAdc
Collector Cutoff Current (V _{CB} = -50 Vdc, I _E = 0) (V _{CB} = -50 Vdc, I _E = 0, T _A = 150 °C)	MPS2907 MPS2907A MPS2907 MPS2907A	Ісво	0	-0.020 -0.010 -20 -10	μAdc
Base Current $(V_{CE} = -30 \text{ Vdc}, V_{EB(off)} = -0.5 \text{ Vdc})$		IB IN	YTUD TUT	-50	nAdc
ON CHARACTERISTICS					
DC Current Gain $(I_{\hbox{\scriptsize C}}=-0.1~\hbox{\scriptsize mAdc}, V_{\hbox{\scriptsize CE}}=-10~\hbox{\scriptsize Vdc})$ $(I_{\hbox{\scriptsize C}}=-1.0~\hbox{\scriptsize mAdc}, V_{\hbox{\scriptsize CE}}=-10~\hbox{\scriptsize Vdc})$ $(I_{\hbox{\scriptsize C}}=-10~\hbox{\scriptsize mAdc}, V_{\hbox{\scriptsize CE}}=-10~\hbox{\scriptsize Vdc})$	MPS2907 MPS2907A MPS2907 MPS2907A MPS2907	hFE	35 75 50 100 75		
$(I_C = -150 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})(1)$ $(I_C = -500 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})(1)$	MPS2907A MPS2907, MPS2907A MPS2907 MPS2907A	n = 80.0.1	100 100 30 50	300	
Collector-Emitter Saturation Voltage (1) (I _C = -150 mAdc, I _B = -15 mAdc) (I _C = -500 mAdc, I _B = -50 mAdc)	an 000	VCE(sat)	0 _	-0.4 -1.6	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = -150 \text{ mAdc}$, $I_B = -15 \text{ mAdc}$) ($I_C = -500 \text{ mAdc}$, $I_B = -50 \text{ mAdc}$)	CAPACITANCE OF TEST JUG AND CONNECT	VBE(sat	_	-1.3 -2.6	Vdc

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

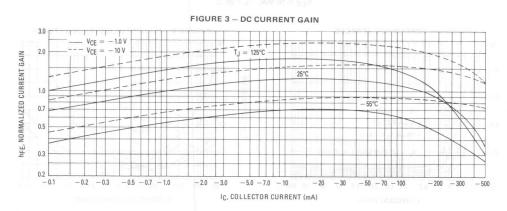
Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL C	HARACTERISTICS				
Current-Gain — Bandwidth Product(1),(2) (I _C = -50 mAdc, V _{CE} = -20 Vdc, f = 100 MHz)		fΤ	200		MHz
Output Capacitance (V _{CB} = -10 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}	<u>v-</u> 0.	8.0	pF
Input Capacitance (VEB = -2.0 Vdc, I _C = 0, f = 1.0 MHz)		C _{ibo}	-	30	pF
SWITCHING CHAP	RACTERISTICS			- J	8
Turn-On Time	$(V_{CC} = -30 \text{ Vdc}, I_{C} = -150 \text{ mAdc},$	ton	++/	45	ns
Delay Time	$I_{B1} = -15 \text{ mAdc}$) (Figures 1 and 5)	td		10	ns
Rise Time		tr		40	ns
Turn-Off Time	$(V_{CC} = -6.0 \text{ Vdc}, I_{C} = -150 \text{ mAdc},$	toff		100	ns
Storage Time	$I_{B1} = I_{B2} = 15 \text{ mAdc}$ (Figure 2)	t _S	_	80	ns
Fall Time		tf	_	30	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.



TYPICAL CHARACTERISTICS



-0.8

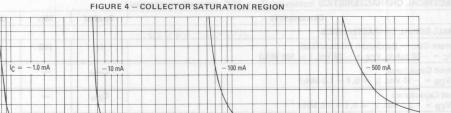
-0.6

-0.4

-0.2

-0.005 -0.01

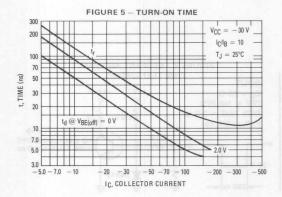
VCE, COLLECTOR-EMITTER VOLTAGE (VOLTS)



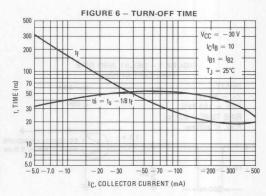
-2.0 -3.0



-0.2 -0.3

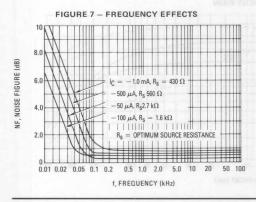


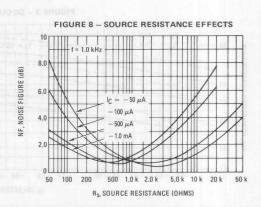
-0.02 -0.03 -0.05 -0.07 -0.1



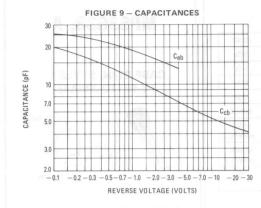
-5.0 - 7.0 - 10

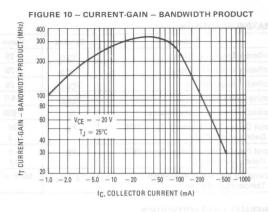
TYPICAL SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE $V_{CE} = 10 \text{ Vdc}, T_A = 25^{\circ}\text{C}$

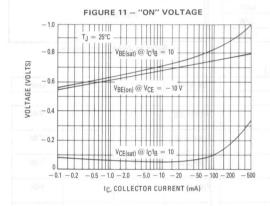


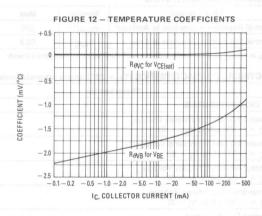


MPS2907, A









Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-25	Vdc
Collector-Emitter Voltage	VCES	-25	Vdc
Collector-Base Voltage	VCBO	-25	Vdc
Emitter-Base Voltage	VEBO	-4.0	Vdc
Collector Current — Continuous	Ic	-500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

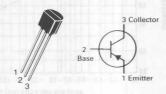
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	200	°C/W
Thermal Resistance, Junction to Case	R_{θ} JC	83.3	°C/W

 $(1)R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

MPS3638, A

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



SWITCHING TRANSISTORS

PNP SILICON

Refer to 2N4402 for graphs.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	W- 1				1
Collector-Emitter Breakdown Voltage (I _C = -100μ Adc, V _{BE} = 0)		V _(BR) CES	- 25		Vdc
Collector-Emitter Sustaining Voltage(1) (I _C = -10 mAdc, I _B = 0)		V _{CEO(sus)}	- 25		Vdc
Collector-Base Breakdown Voltage $(I_C = -100 \mu Adc, I_E = 0)$		V(BR)CBO	- 25		Vdc
Emitter-Base Breakdown Voltage $(I_E = -100 \mu Adc, I_C = 0)$		V _{(BR)EBO}	-4.0	at —	Vdc
Collector Cutoff Current $(V_{CE} = -15 \text{ Vdc}, V_{BE} = 0)$ $(V_{CE} = -15 \text{ Vdc}, V_{BE} = 0, T_{A} = -65^{\circ}\text{C})$		ICES	Ξ	-0.035 -2.0	μAdc
Emitter Cutoff Current (V _{EB} = -3.0 V, I _C = 0)		IEBO	_	-35	nA
Base Current (V _{CE} = -15 Vdc, V _{BE} = 0)		IB	_	-0.035	μAdc
ON CHARACTERISTICS(1)			100		
DC Current Gain ($I_C = -1.0 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$)	MPS3638A	hFE	80	_	
$(I_C = -10 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})$	MPS3638A		20 100	=	
$(I_C = -50 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})$	MPS3638 MPS3638A		30 100	= 1	
$(I_C = -300 \text{ mAdc}, V_{CE} = -2.0 \text{ Vdc})$	MPS3638 MPS3638A		20 20		
Collector-Emitter Saturation Voltage ($I_C = -50 \text{ mAdc}$, $I_B = -2.5 \text{ mAdc}$) ($I_C = -300 \text{ mAdc}$, $I_B = -30 \text{ mAdc}$)		VCE(sat)	=	-0.25 -1.0	Vdc
Base-Emitter Saturation Voltage ($I_C = -50$ mAdc, $I_B = -2.5$ mAdc) ($I_C = -300$ mAdc, $I_B = -30$ mAdc)		V _{BE} (sat)	 -0.80	-1.1 -2.0	Vdc

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

	Characteristic			Symbol	Min	Max	Unit	
SMALL-SIGNA	L CHAF	RACTERISTICS			The state of the s		SBIAMAS	MUMINA
Current-Gain – (V _{CE} = -3.0		width Product C = -50 mAdd	c, f = 100 MHz) MPS3638 MPS3638A	GESV fT	100 150	epular patra	MHz
Output Capacit	tance			III GGGGG/T	C _{obo}			pF
		= 0, f = 1.0 N	1Hz)	MPS3638 MPS3638A	2000	_9,000,00	20 10	n sufficient
Input Capacital (VEB = -0.5		C = 0, f = 1.0	MHz)	MPS3638 MPS3638A	C _{ibo}	- 25°C	65 25	pF
Input Impedan		CE = -10 Vdc	, f = 1.0 kHz)	Sale 180 C	h _{ie}	neuro	2000	Ohms
Voltage Feedba		$V_{CE} = -10 \text{ Vdc}$, f = 1.0 kHz)	MPS3638 MPS3638A	h _{re}	-	26 15	X 10-4
Small-Signal C (I _C = -10 m		Gain CE = -10 Vdc	, f = 1.0 kHz)	MPS3638 MPS3638A	h _{fe}	25 100	ahose (i) mut <u>s</u> na	298 (67078
Output Admitta		′CE = −10 Vdc	;, f = 1.0 kHz)	MO E'SR	h _{oe}	100 to 12.54	1.2	mmhos
SWITCHING C				French samur	milin seemi You a a'	ri et itteleat	mana in	A OFFICE
Delay Time	- 4.		Vdc, I _C = -300) mAdc,	t _d	urth —	20	ns
Rise Time		$I_{B1} = -30 \text{ m}$			t _r	_	70	ns
Storage Time		$(V_{CC} = -10)$	/dc, I _C = -300	mAdc,	av ab a corts	months of con	140	ns
Fall Time			Adc, $I_{B2} = -3$		al obaction t _f	Lian or V as	70	ns
Turrf-On Time		$(I_{C} = -300 \text{ m})$	Adc, I _{B1} = -3	30 mAdc)	ton	Moltana III	75	ns
Turn-Off Time				30 mAdc, I _{B2} = 30 mAdc)			170	ns

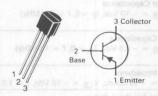
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-12	Vdc
Collector-Base Voltage	VCBO	-12	Vdc
Emitter-Base Voltage	VEBO	-4.0	Vdc
Collector Current — Continuous	Ic	-80	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derante above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

THERIWAL CHARACTERISTICS						
Characteristic	Symbol	Max	Unit			
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W			
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W			

MPS3640

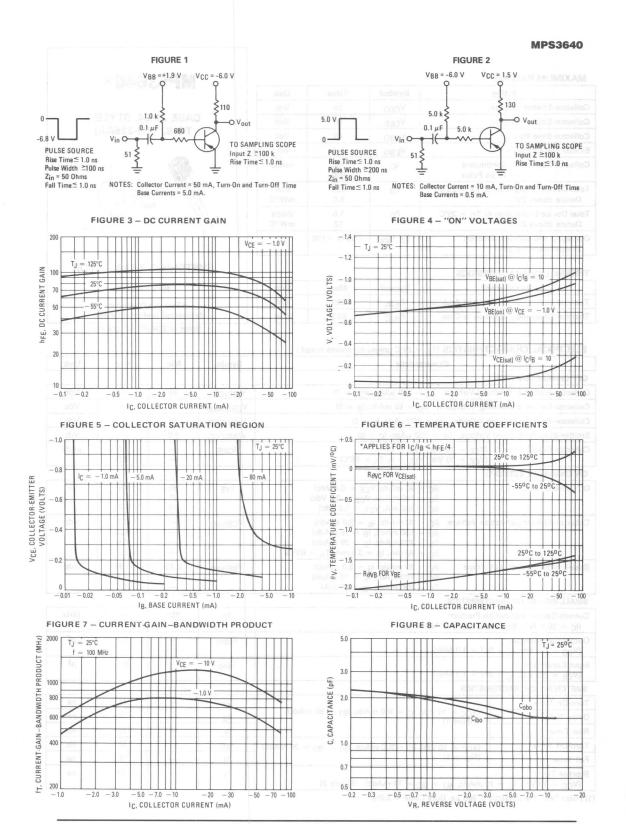
CASE 29-04, STYLE 1 TO-92 (TO-226AA)



SWITCHING TRANSISTOR

PNP SILICON

20 ns	Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERIST	ics	(00)	PERMIT USE	TBI	emiT e
Collector-Emitter Bre	eakdown Voltage ($I_C = -100 \mu Adc, V_{BE} = 0$)	V(BR)CES	-12	(V)	Vdc
Collector-Emitter Sus	staining Voltage(1) ($I_C = -10 \text{ mAdc}, I_B = 0$)	VCEO(sus)	-12	H	Vdc
Collector-Base Break	down Voltage (I _C = -100μ Adc, I _E = 0)	V(BR)CBO	-12	3D _ #	Vdc
Emitter-Base Breakdo	own Voltage ($I_E = -100 \mu\text{Adc}, I_C = 0$)	V(BR)EBO	-4.0	911 <u> </u>	Vdc
Collector Cutoff Curr	ent $(V_{CE} = -6.0 \text{ Vdc}, V_{BE} = 0)$ $(V_{CE} = -6.0 \text{ Vdc}, V_{BE} = 0, T_{A} = 65^{\circ}\text{C})$	ICES	NO NITE OF	- 0.01 - 1.0	μAdc
Base Current — (VCE	$E = -6.0 \text{ Vdc}, V_{EB} = 0)$	IB	_	-10	nAdc
ON CHARACTERISTI	CS(1)				
	S = -10 mAdc, V _{CE} = -0.3 Vdc) S = -50 mAdc, V _{CE} = -1.0 Vdc)	hFE	30 20	120 —	-
Collector-Emitter Saturation Voltage $ \begin{array}{c} (I_C=-10 \text{ mAdc, } I_B=-1.0 \text{ mAdc}) \\ (I_C=-50 \text{ mAdc, } I_B=-5.0 \text{ mAdc}) \\ (I_C=-10 \text{ mAdc, } I_B=-1.0 \text{ mAdc, } I_A=65^{\circ}\text{C}) \end{array} $		VCE(sat)	Ξ	-0.2 -0.6 -0.25	Vdc
Base-Emitter Saturation Voltage $(I_C=-10 \text{ mAdc}, I_B=-0.5 \text{ mAdc})$ $(I_C=-10 \text{ mAdc}, I_B=-1.0 \text{ mAdc})$ $(I_C=-50 \text{ mAdc}, I_B=-5.0 \text{ mAdc})$		V _{BE(sat)}	-0.75 -0.75 -	- 0.95 - 1.0 - 1.5	Vdc
SMALL-SIGNAL CHA	RACTERISTICS				
Current-Gain — Band (I _C = -10 mAdc,	dwidth Product V _{CE} = -5.0 Vdc, f = 100 MHz)	fT	500	_	MHz
Output Capacitance	$(V_{CB} = -5.0 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz})$	Cobo		3.5	pF
Input Capacitance ($V_{EB} = -0.5 \text{ Vdc}, I_{C} = 0, f = 1.0 \text{ MHz})$	Cibo	_	3.5	pF
SWITCHING CHARAC	CTERISTICS				
Delay Time	$(V_{CC} = -6.0 \text{ Vdc}, I_{C} = -50 \text{ mAdc}, V_{BE(off)} = -1.9 \text{ Vdc},$	t _d		10	ns
Rise Time	$I_{B1} = -5.0 \text{ mAdc}$	t _r	_	30	ns
Storage Time	$(V_{CC} = -6.0 \text{ Vdc}, I_{C} = -50 \text{ mAdc}, I_{B1} = I_{B2} = -5.0 \text{ mAdc})$	t _S	_	20	ns
Fall Time		tf	-	12	ns
Turn-On Time ($V_{CC}=-6.0$ Vdc, $I_{C}=-50$ mAdc, $I_{B1}=-5.0$ mAdc) ($V_{CC}=-1.5$ Vdc, $I_{C}=-10$ mAdc, $I_{B1}=-0.5$ mAdc)		^t on	=	25 60	ns
Turn-Off Time $(V_{CC} = -6.0 \text{ Vdc}, I_{C} = -50 \text{ mAdc}, I_{B1} = I_{B2} = -5.0 \text{ mAdc})$ $(V_{CC} = -1.5 \text{ Vdc}, I_{C} = -10 \text{ mAdc}, I_{B1} = I_{B2} = -0.5 \text{ mAdc})$		toff	Ξ	35 75	ns



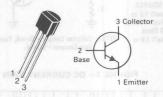
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	15	Vdc
Collector-Emitter Voltage	VCES	40	Vdc
Collector-Base Voltage	VCBO	40	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous — 10 μs Pulse	Ic	300 500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

MPS3646*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



SWITCHING TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Refer to 2N4264 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

11 10 10 10 10 10 10 10 10 10 10 10 10 1	Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown	Voltage (I _C = 100 μAdc, V _{BE} = 0)	V(BR)CES	40	AI 3D -	Vdc
Collector-Emitter Sustaining	Voltage(1) $(I_C = 10 \text{ mAdc}, I_B = 0)$	VCEO(sus)	15	03.3-	Vdc
Collector-Base Breakdown V	oltage (I _C = 100 μAdc, I _E = 0)	V(BR)CBO	40	na i ma	Vdc
Emitter-Base Breakdown Vol	tage ($I_E = 100 \mu Adc, I_C = 0$)	V(BR)EBO	5.0	_	Vdc
Collector Cutoff Current (V	CE = 20 Vdc, VBE = 0) CE = 20 Vdc, VBE = 0, TA = 65°C)	ICES		0.5 3.0	μAdc
ON CHARACTERISTICS(1)	AND THE PROPERTY OF THE PARTY O			Age O	
DC Current Gain	$(I_C = 30 \text{ mAdc}, V_{CE} = 0.4 \text{ Vdc})$ $(I_C = 100 \text{ mAdc}, V_{CE} = 0.5 \text{ Vdc})$ $(I_C = 300 \text{ mA}, V_{CE} = 1.0 \text{ Vdc})$	hFE	30 25 15	120 —	T
Collector-Emitter Saturation	Voltage (I _C = 30 mAdc, I _B = 3.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) (I _C = 30 mA, I _B = 3.0 mA, T _A = 65°C)	VCE(sat)	Ē	0.2 0.28 0.5 0.3	Vdc
Base-Emitter Saturation Voltage $ \begin{array}{c} (I_C=30 \text{ mAdc}, I_B=3.0 \text{ mAdc}) \\ (I_C=100 \text{ mAdc}, I_B=10 \text{ mAdc}) \\ (I_C=300 \text{ mAdc}, I_B=30 \text{ mA}) \end{array} $		V _{BE} (sat)	0.73	0.95 1.2 1.7	Vdc
SMALL-SIGNAL CHARACTE	RISTICS	MANUT	UPRRIED ARGS	tut- env-	101
Current-Gain — Bandwidth F (I _C = 30 mAdc, V _{CE} = 10		ft goas high	350	CURR ENT	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f	= 1.0 MHz)	C _{obo}	TIL	5.0	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f	= 1.0 MHz)	C _{ibo}	= 30-4	9.0	pF
SWITCHING CHARACTERIST	TICS				
Turn-On Time		ton		18	ns
(V _{CC} = 10 Vdc, I _C = 300 mAdc, I _{B1} = 30 mAdc) (Figure 1)		td		10	ns
Rise Time	(rigure 1)		-	15	ns
Turn-Off Time ($V_{CC} = 10 \text{ Vdc}, I_{C} = 300 \text{ mAdc}, I_{B1} = I_{B2} = 30 \text{ mAdc})$	toff		28	ns
	(Figure 1)			15	ns
Storage Time (V _{CC} = 10 Vdc, I _C = 10 m	nAdc, I _{B1} = I _{B2} = 10 mAdc) (Figure 2)	t _S	-	18	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 - SWITCHING TIME TEST CIRCUIT

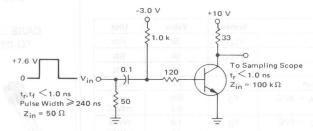
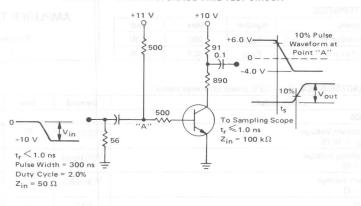


FIGURE 2 - CHARGE STORAGE TIME TEST CIRCUIT



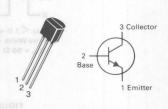
MAXIMON NATINGO	1, 19, 11		
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	30	Vdc
Collector-Base Voltage	VCBO	55	Vdc
Emitter-Base Voltage	VEBO	3.5	Vdc
Collector Current — Continuous	IC	0.4	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	R _{0-IC}	83.3	°C/W

MPS3866

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



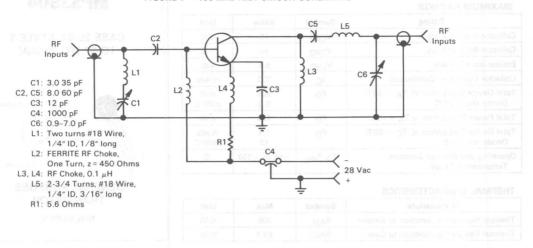
AMPLIFIER TRANSISTOR

NPN SILICON

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	00	T comments		
Collector-Emitter Breakdown Voltage (I _C = 5.0 mAdc, R _{BE} = 10 Ω)	VCER(sus)	55	_	Vdc
Collector-Emitter Sustaining Voltage (IC = 5.0 mAdc, IB = 0)	VCEO(sus)	30	_	Vdc
Emitter-Base Breakdown Voltage (IE = 100 μ Adc, IC = 0)	V(BR)EBO	3.5	-	Vdc
Collector Cutoff Current $(V_{CE} = 28 \text{ Vdc}, I_B = 0)$	ICES	-	0.02	mAdc
Collector Cutoff Current ($V_{CE} = 30 \text{ Vdc}$, $V_{EB} = -1.5 \text{ Vdc}$ (Rev.), $T_{C} = 150^{\circ}\text{C}$) ($V_{CE} = 55 \text{ Vdc}$, $V_{EB} = -1.5 \text{ Vdc}$ (Rev.)	ICEX	=	5.0 0.1	mAdc
Emitter Cutoff Current (V _{EB} = 3.5 Vdc, I _C = 0)	IEBO	-	0.1	mAdc
ON CHARACTERISTICS				
DC Current Gain (I _C = 360 mAdc, V_{CE} = 5.0 Vdc)(1) (I _C = 50 mAdc, V_{CE} = 5.0 Vdc)	hFE	5.0 10	200	-
Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 20 mAdc)	VCE(sat)	-	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 15 Vdc, f = 200 MHz)	fτ	500	-	MHz
Output Capacitance (V _{CB} = 28 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	Ī	3.0	pF
FUNCTIONAL TEST			*	
Amplifier Power Gain (V _{CC} = 28 Vdc, P _{out} = 1.0 W, f = 400 MHz)	Gpe	10	_	dB
Collector Efficiency (V _{CC} = 28 Vdc, P _{out} = 1.0 W, f = 400 MHz)	η	45	-	%

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 - 400 MHz TEST CIRCUIT SCHEMATIC



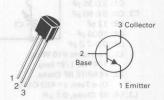
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	VCBO	60	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	Ic	100	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Power Dissipation @ T _A = 60°C	PD	450	mW
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	R⊕JC	83.3	°C/W

MPS3904

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0)	V(BR)CEO	40	-	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _E = 0)	V(BR)CBO	60	-	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V(BR)EBO	6.0	-	Vdc
Collector Cutoff Current (VCE = 30 Vdc, VEB(off) = 3.0 Vdc)	ICEX	7	50	nAdc
Base Cutoff Current (V _{CE} = 30 Vdc, V _{EB(off)} = 3.0 Vdc)	IBL	_	50	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain	hFE	40 70 100 60 30	300	_
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc)	VCE(sat)	=	0.2 0.3	Vdc
Base-Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}$, $I_B = 1.0 \text{ mAdc}$) ($I_C = 50 \text{ mAdc}$, $I_B = 5.0 \text{ mAdc}$)	V _{BE(sat)}	0.65	0.85 1.1	Vdc

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

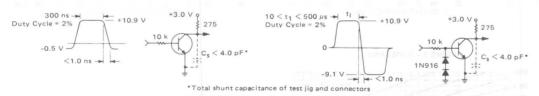
	Characteristic	Symbol	Min	Max	Unit
SMALL-SIGNAL C	HARACTERISTICS				
Current-Gain — Ba (I _C = 10 mAdc,	andwidth Product VCE = 20 Vdc, f = 100 MHz)	ft ^{AT 30}	200	ERNOTA	MHz
Output Capacitano (V _{CB} = 5.0 Vdc	te , I _E = 0, f = 1.0 MHz)	C _{obo}	+	4.0	pF
Input Capacitance (V _{EB} = 0.5 Vdc,	I _C = 0, f = 1.0 MHz)	C _{ibo}	T	8.0	pF
Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)		h _{ie}	1.0	10	kΩ
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)		h _{re}	0.5	8.0	X 10-4
Small-Signal Curro (I _C = 1.0 mAdc,	ent Gain . V _{CE} = 10 Vdc, f = 1.0 kHz)	h _{fe}	100	400	A 101
Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)		h _{oe}	1.0	40	μmhos
Noise Figure (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 1.0 k Ω , f = 1.0 kHz)		NF	(Name	5.0	dB
SWITCHING CHAP	RACTERISTICS				
Delay Time	DE(OII)		n ven oli n ve	35	ns
Rise Time	I _C = 10 mAdc, I _{B1} = 1.0 mAdc)	t _r	_	50	ns
Storage Time	(V _{CC} = 3.0 Vdc, I _C = 10 mAdc,	t _S		900	ns
Fall Time	$I_{B1} = I_{B2} = 1.0 \text{ mAdc}$	tf		90	ns

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

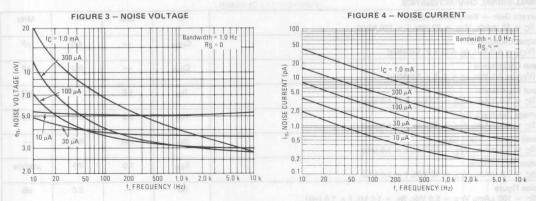
EQUIVALENT SWITCHING TIME TEST CIRCUITS

FIGURE 1 - TURN-ON TIME

FIGURE 2 - TURN-OFF TIME



TYPICAL NOISE CHARACTERISTICS (VCF = 5.0 Vdc, TA = 25°C)



NOISE FIGURE CONTOURS (VCE = 5.0 Vdc, TA = 25°C)

FIGURE 5 — NARROW BAND, 100 Hz

500 k

(SWH)

500 k

(SWH)

500 k

(SWH)

500 k

(SWH)

500 k

8 andwidth = 1.0 Hz

10 k

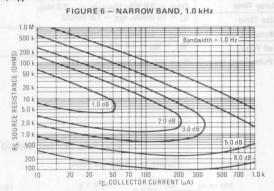
500 k

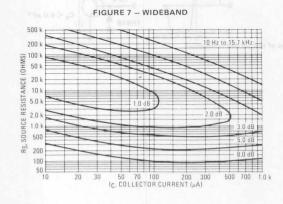
8 andwidth = 1.0 Hz

10 k

6.0 dB

10 dB





Noise Figure is Defined as:

NF =
$$20 \log_{10} \left(\frac{e_n^2 + 4KTR_S + I_n^2 R_S^2}{4KTR_S} \right) \frac{1}{2}$$

en = Noise Voltage of the Transistor referred to the input. (Figure 3)

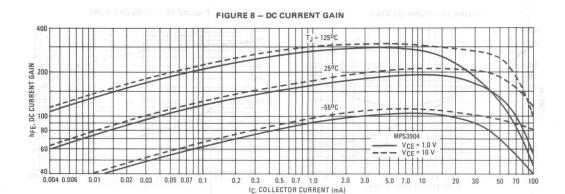
In = Noise Current of the transistor referred to the input (Figure 4)

K = Boltzman's Constant (1.38 \times 10⁻²³ j/ $^{\circ}$ K)

T = Temperature of the Source Resistance (OK)

R_S = Source Resistance (Ohms)

TYPICAL STATIC CHARACTERISTICS





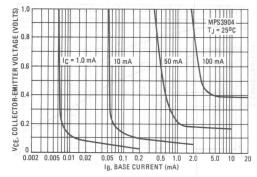


FIGURE 10 - COLLECTOR CHARACTERISTICS

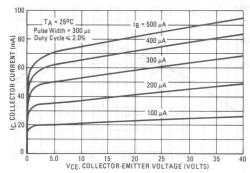


FIGURE 11 - "ON" VOLTAGES

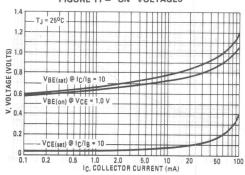
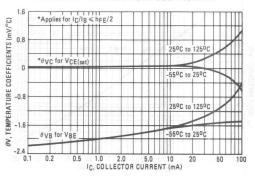
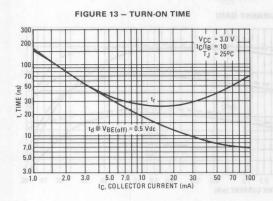
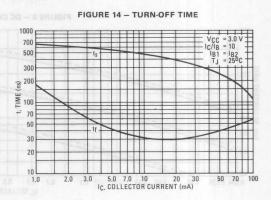


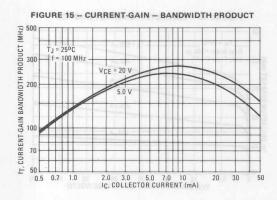
FIGURE 12 - TEMPERATURE COEFFICIENTS

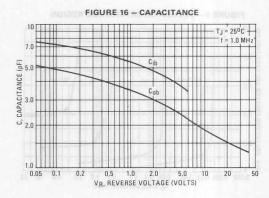


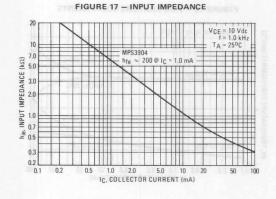
TYPICAL DYNAMIC CHARACTERISTICS

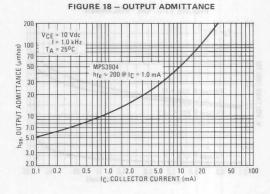












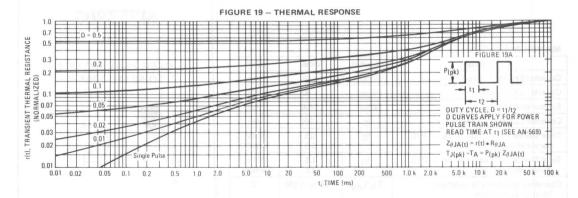


FIGURE 19A VCC = 30 Vdc COLLECTOR CURRENT (nA) 100 ICEX @ VBE(off) = 3.0 Vdc 10-10-2 +100 +120 +140 +160 -40 +60 +80 T.J. JUNCTION TEMPERATURE (°C)

DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 19A. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 19 was calculated for various duty cycles.

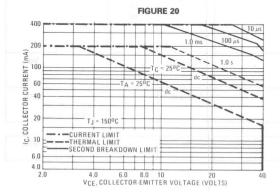
To find Z_{0.JA(t)}, multiply the value obtained from Figure 19 by the steady state value $R_{\theta,JA}$.

Example:

The MPS3904 is dissipating 2.0 watts peak under the following conditions:

 $t_1 = 1.0$ ms, $t_2 = 5.0$ ms. (D = 0.2) Using Figure 19 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

The peak rise in junction temperature is therefore $\Delta T = r(t) \times P_{(pk)} \times R_{\theta}JA = 0.22 \times 2.0 \times 200 = 88^{\circ}C.$ For more information, see AN-569.



The safe operating area curves indicate IC-VCE limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 20 is based upon $T_{J(pk)} = 150^{\circ}C$; To or TA is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided TJ(pk) ≤ 150°C. TJ(pk) may be calculated from the data in Figure 19. At high case or ambient temperatures, thermal limitations will reduce the power than can be handled to values less than the limitations imposed by second breakdown.

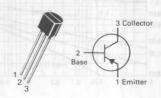
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-40	Vdc
Collector-Base Voltage	VCBO	-40	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current — Continuous	Ic	-200	Vdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	ReJC	83.3	°C/W

MPS3906

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N5086 for graphs.

Symbol	Min	Max	Unit
			201
V _(BR) CEO	-40	-	Vdc
V(BR)CBO	-40		Vdc
V(BR)EBO	-5.0		Vdc
ICEX	der Dr. D	-50	nAdc
IBL	identi <u>r m</u> antay	-50	nAdc
hFE 05 30	60 80 100 60 30	300	100 - 4 - 005
VCE(sat)		-0.25 -0.4	Vdc
V _{BE} (sat)	-0.65 —	- 0.85 - 0.95	Vdc
		THE ROLL OF	
fT	250	J JAH <u>S E</u> HI - T	MHz
	V(BR)CBO V(BR)EBO ICEX IBL hFE VCE(sat) VBE(sat)	V(BR)CBO -40 V(BR)EBO -5.0 ICEX - IBL - hFE 60 80 100 60 30 VCE(sat) - VBE(sat) -0.65 -	V(BR)CBO -40 — V(BR)EBO -5.0 — ICEX — -50 IBL — -50 hFE 60 — 80 — 100 300 60 — 30 — 100 300 60 — 30 — 100 100 100 100 100 100 100 100 100

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
Output Capacitance (V _{CB} = -5.0 Vdc, I _E = 0, f = 1.0 MHz)			C _{obo}	_	4.5	pF
Input Capacitance (V _{EB} = -0.5 Vdc, I _C = 0, f = 1.0 MHz)	Mat)	70 29 29 29 29 29 29 29 29 29 29 29 29 29	C _{ibo}	_	10	pF Geleciel ED
Input Impedance (I _C = -1.0 mAdc, V _{CE} = -10 Vdc, f = 1.0 kHz)	abV abV	0.0	o∀ h _{ie}	2.0	12	k ohms
Voltage Feedback Ratio $(I_C = -1.0 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}, f = 1.0 \text{ kHz})$	obAm.	200	h _{re}	1.0	10 10	X 10-4
Small-Signal Current Gain $(I_C = -1.0 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}, f = 1.0 \text{ kHz})$	x iV/or	5.0	h _{fe}	100	400	De re te so. Possi Pessa
Output Admittance ($I_C = -1.0 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	ST Wm	12	h _{oe}	3.0	60	μmhos
Noise Figure (I _C = -100μ Adc, V _{CE} = -5.0 Vdc , R _S = 1.0 k o	hm, f = 1	1.0 kHz)	NF	-	4.0	dB

SWITCHING CHARACTERISTICS

Delay Time	$(V_{CC} = -3.0 \text{ Vdc}, V_{BE(off)} = +0.5 \text{ Vdc},$ $I_{C} = -10 \text{ mAdc}, I_{D1} = 1.0 \text{ mAdc})$	t _d		35	ns
Rise Time	$I_C = -10 \text{ mAdc}, I_{B1} = 1.0 \text{ mAdc})$	t _r	5 S S S S S S S S S S S S S S S S S S S	50	ns
Storage Time	$(V_{CC} = -3.0 \text{ Vdc}, I_{C} = -10 \text{ mAdc},$	t _S	-0.00 0/10	600	ns
Fall Time	$I_{B1} = I_{B2} = -1.0 \text{ mAdc}$	t _f	PRINTERS O	90	ns

⁽¹⁾ Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

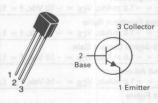
Rating	Symbol	MPS4123	MPS4124	Unit
Collector-Emitter Voltage	VCE	30	25	Vdc
Collector-Base Voltage	VCB	40	30	Vdc
Emitter-Base Voltage	VEB	5	.0	Vdc
Collector Current — Continuous	er Ic	2	00	mAdc
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C
Total Power Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		W mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to	+ 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

MPS4123 MPS4124

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 1.0 mA, I _B = 0)	MPS4123 MPS4124	V(BR)CEO	30 25	=	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu A, I_E = 0$)	MPS4123 MPS4124	V(BR)CBO	40 30		Vdc
Emitter-Base Breakdown Voltage (I _C = 0, I _E = 10	μΑ)	V(BR)EBO	5.0	- 1	Vdc
Collector Cutoff Current (V _{CB} = 20 V, I _E = 0)		ICBO	-	50	nAdc
Emitter Cutoff Current (VEB = 3.0 V, IC = 0)		IEBO	_	50	nAdc
ON CHARACTERISTICS				End e	
DC Current Gain ($I_C = 2.0$ mA, $V_{CE} = 1.0$ V) ($I_C = 50$ mA, $V_{CE} = 1.0$ V)	MPS4123 MPS4124 MPS4123 MPS4124	hFE	50 120 25 60	150 360 —	_
Collector-Emitter Saturation Voltage (I _C = 50 mA, I _B = 5.0 mA)		VCE(sat)		0.3	Vdc
Base-Emitter Saturation Voltage (I _C = 50 mA, I _B = 5.0 mA)		V _{BE} (sat)	_	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = 10 mA, V _{CE} = 20 V, f = 100 MHz)	MPS4123 MPS4124	fT	100 170		MHz
Output Capacitance $(V_{CB} = 5.0 \text{ V, I}_{E} = 0, f = 1.0 \text{ MHz})$		C _{ob}		4.0	pF
Input Capacitance (V _{EB} = 0.5 V, I _C = 0, f = 1.0 MHz)	MPS4123 MPS4124	C _{ib}		14 13.5	pF
Small-Signal Current Gain (I _C = 2.0 mA, V _{CE} = 1.0 V, f = 1.0 kHz)	MPS4123 MPS4124	h _{fe}	50 120	200 480	
Noise Figure (I _C = 100 μ A, V _{CE} = 5.0 V, R _S = 1.0 k Ω , f = 1.0 kHz)	MPS4123 MPS4124	NF	Ξ	6.0 5.0	dB

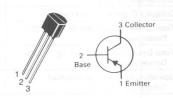
Rating	Symbol	MPS4125	MPS4126	Unit
Collector-Emitter Voltage	VCE	-30	- 25	Vdc
Collector-Base Voltage	V _{CB}	-10	- 25	Vdc
Emitter-Base Voltage	VEB	oby -	4.0	Vdc
Collector Current — Continuous	Ic	JAm -	200	mAdc
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PD		25 .0	mW mW/°C
Total Power Dissipation @ T _C = 25°C Derate above 25°C	PD		.5	W mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to	+ 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

MPS4125 MPS4126

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS				SUPPLIES 1,27	an late take
Collector-Emitter Breakdown Voltage (I _C = -1.0 mA, I _B = 0)	MPS4125 MPS4126	V(BR)CEO	-30 -25		Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu A, I_E = 0$)	MPS4125 MPS4126	V(BR)CBO	-30 -25		Vdc
Emitter-Base Breakdown Voltage (I _C = 0, I _E = -10	μΑ)	V(BR)EBO	-4.0	- 28	Vdc
Collector Cutoff Current (V _{CB} = -20 V, I _E = 0)		ICBO	and the Manager	-50	nAdc
Emitter Cutoff Current (V _{EB} = -3.0 V, I _C = 0)		I _{EBO}	_	-50	nAdc
ON CHARACTERISTICS				more to to the	U naselle3
DC Current Gain $(I_C = -2.0 \text{ mA}, V_{CE} = -1.0 \text{ V})$ $(I_C = -50 \text{ mA}, V_{CE} = -1.0 \text{ V})$	MPS4125 MPS4126 MPS4125 MPS4126	hFE	50 120 25 60	150 360 —	VCB - (VCB - (VC
Collector-Emitter Saturation Voltage (I _C = -50 mA, I _B = -5.0 mA)		V _{CE(sat)}	=	-0.4	Vdc
Base-Emitter Saturation Voltage (I _C = -50 mA, I _B = -5.0 mA)		V _{BE(sat)}	(V -)	-0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS			(Am 6.0 -	The lates	+ 50
Current Gain — Bandwidth Product (I _C = -10 mA, V _{CE} = -20 V, f = 100 MHz)	MPS4125 MPS4126	fT	150 170	acqu - sa i	MHz
Output Capacitance ($V_{CB} = -5.0 \text{ V}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)		C _{ob}	este de la composición della c	4.5	pF _M a
Input Capacitance (V _{EB} = -0.5 V, I _C = 0, f = 1.0 MHz)	MPS4125 MPS4126	C _{ib}	— XM 0.	12 11.5	pF
Small-Signal Current Gain (I _C = -2.0 mA, V _{CE} = -1.0 V, f = 1.0 kHz)	MPS4125 MPS4126	h _{fe}	50 120	200 480	877
Noise Figure (I _C = $-100~\mu$ A, V _{CE} = $-5.0~\text{V}$, R _S = $1.0~\text{k}\Omega$, f = $1.0~\text{kHz}$)	MPS4125 MPS4126	(NF A)	1,V 0.8	5.0 4.0	dB

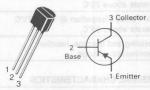
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-40	Vdc
Collector-Emitter Voltage	VCES	-40	Vdc
Collector-Base Voltage	VCBO	-40	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current - Continuous	Ic	m _ 00%-	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W



CASE 29-04, STYLE 1 TO-92 (TO-226AA)



TRANSISTORS

PNP SILICON

V(BR)CEO(sus) V(BR)CBO V(BR)EBO ICBO	-40 -40 -5.0	-10 -3.0 -20	Vdc Vdc Vdc Vdc A A A A A A A A A A A A A A A A A A
V(BR)CEO(sus) V(BR)CBO V(BR)EBO	-40 -40 -5.0	-10 -3.0 -20	Vdc Vdc Vdc nA μA
V(BR)CBO V(BR)EBO	-40 -5.0	-10 -3.0 -20	Vdc Vdc nA μA
V _{(BR)EBO}	-5.0 - -	-10 -3.0 -20	Vdc nA μA
ІСВО	A 0 1 = 8	- 10 - 3.0 - 20	nA μA
	_	-10 -3.0 -20	nA μA
I _{EBO}	V 0.1 - =		nA
		-	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
hFE	250 250	50 mA, (g. + ior 8 zuratio	- romalio. - = 31) im3-resi
VCE(sat)	ACTERISTI	-0.25	Vdc
V _{BE(sat)}	Jon 2 100 L	-0.9	Vdc
		eonerioso	aO sugstif
C _{obo}	0,1 = 1,0	6.0	pF
Cibo	niei	16	pF
h _{fe}	250 2.0	800	uoise Figu (Ig = -
NF	-	2.0	dB
	VCE(sat) VBE(sat) Cobo Cibo hfe	250 250 VCE(sat)	250

⁽¹⁾ Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-12	Vdc
Collector-Base Voltage	VCBO	-12	Vdc
Emitter-Base Voltage	VEBO	-4.5	Vdc
Collector Current — Continuous	IC	-80	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

MPS4258 CASE 29-04, STYLE 1 TO-92 (TO-226AA) 3 Collector 2 Base 1 Emitter SWITCHING TRANSISTOR

Refer to MPS3640 for graphs.

PNP SILICON

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	_ r sausin			
Collector-Emitter Breakdown Voltage(1) ($I_C = -100 \mu Adc, V_{BE} = 0$)	V(BR)CES	-12	_	Vdc
Collector-Emitter Sustaining Voltage(1) (I _C = -3.0 mAdc, I _B = 0)	V _{CEO(sus)}	-12	_	Vdc
Collector-Base Breakdown Voltage ($I_C = -100 \mu Adc$, $I_E = 0$)	V(BR)CBO	-12	_	Vdc
Emitter-Base Breakdown Voltage ($I_E = -100 \mu Adc, I_C = 0$)		-4.5		Vdc
Collector Cutoff Current $(V_{CE} = -6.0 \text{ Vdc}, V_{BE} = 0)$ $(V_{CE} = -6.0 \text{ Vdc}, V_{BE} = 0, T_{A} = +65^{\circ}\text{C})$	ICES	_	-0.01 -5.0	μAdc
ON CHARACTERISTICS	=			
DC Current Gain	hFE	15 30 30	120 —	_
Collector-Emitter Saturation Voltage ($I_C = -10$ mAdc, $I_B = -1.0$ mAdc) ($I_C = -50$ mAdc, $I_B = -5.0$ mAdc)	VCE(sat)	_	- 0.15 - 0.5	Vdc
Base-Emitter On Voltage ($I_C = -10$ mAdc, $I_B = -1.0$ mAdc) ($I_C = -50$ mAdc, $I_B = -5.0$ mAdc)	V _{BE(sat)}	-0.75 -	- 0.95 - 1.5	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current Gain — Bandwidth Product(2) ($I_C = -10 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$, $f = 100 \text{ MHz}$)	fT	700	_	MHz
Input Capacitance ($V_{EB} = -0.5 \text{ Vdc}$, $I_{C} = 0$, $f = 1.0 \text{ MHz}$)	C _{ibo}	_	3.5	pF
Collector-Base Capacitance ($V_{CB} = -5.0 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C _{cb}	-	3.0	pF

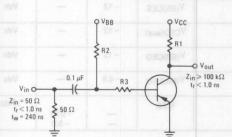
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

	Characteristic			Symbol	Min	Max	Unit
SWITCHING CHARA	ACTERISTICS			Guns.		ORGANICA OR	0.0710230
Turn-On Time	(V _{CC} = -1.5 Vdc,	shAm.	0.8-	ton	_	15	ns
Delay Time	$V_{EB(off)} = 0,$ $I_{C} = -10 \text{ mAdc}, I_{B1} = -1.0 \text{ mAdc}$	1		t _d	800011	10	ns
Rise Time		mAdc)		t _r	ner-W	15	ns
Turn-Off Time	$(V_{CC} = -1.5 \text{ Vdc},$	etreW	8.7	toff	THE E SET	20	ns
Storage Time	$I_C = -10 \text{ mAdc},$			t _S		10	ns
Fall Time	$I_{B1} = I_{B2} = -1.0 \text{ mAdc}$	25	-55 to -1100	tf	notion	20	ns
Storage Time (I _C ≈ −10 mAdc,	I _{B1} ≈ −10 mAdc, I _{B2} ≈ 10 mAd	ic)		t _S	_	20	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

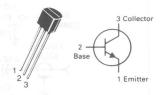




	V _{in} Volts	V _{BB} Volts	V _{CC} Volts	R1 Ohms	R2 Ohms		IC mA	IB1 mA	IB2 mA
ton	-5.8	GND	-1.5	130	2.2 k	5 k	10	1.0)f -
toff	+9.8	-8.0	-1.5	130	2.2 k	5 k	10	1.0	1.0
ts	+9.0	-10	-3.0	270	510	390	10	10	10

MPS5179*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



HIGH FREQUENCY TRANSISTOR

NPN SILICON

★This is a Motorola
designated preferred device.

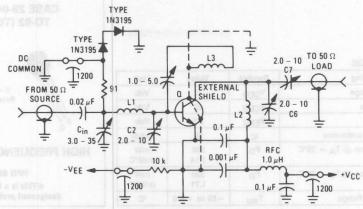
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	12	Vdc
Collector-Base Voltage	VCBO	20	Vdc
Emitter-Base Voltage	VEBO	2.5	Vdc
Collector Current — Continuous	IC	50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	200 1.14	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	300 1.71	mW mW/°C
Storage Temperature Range	T _{stg}	-55 to +150	°C

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	The second secon			
Collector-Emitter Sustaining Voltage (I _C = 3.0 mAdc, I _B = 0)	VCEO(sus)	12	_	Vdc
Collector-Base Breakdown Voltage (I _C = 0.001 mAdc, I _E = 0)	V(BR)CBO	20	_	Vdc
Emitter-Base Breakdown Voltage (I _E = 0.01 mAdc, I _C = 0)	V(BR)EBO	2.5	_	Vdc
Collector Cutoff Current $(V_{CB} = 15 \text{ Vdc}, I_E = 0)$ $(V_{CB} = 15 \text{ Vdc}, I_E = 0, T_A = 150^{\circ}\text{C})$	ІСВО	=	0.02 1.0	μAdc
ON CHARACTERISTICS				
DC Current Gain (I _C = 3.0 mAdc, V _{CE} = 1.0 Vdc)	hFE	25	250	-
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	VCE(sat)	_	0.4	Vdc
Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	V _{BE} (sat)	_	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product(1) (IC = 5.0 mAdc, VCE = 6.0 Vdc, f = 100 MHz)	fT	900	2000	MHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 0.1 to 1.0 MHz)	C _{cb}	_	1.0	pF
Small Signal Current Gain (I _C = 2.0 mAdc, V _{CE} = 6.0 Vdc, f = 1.0 kHz)	h _{fe}	25	300	-
Collector Base Time Constant (I _E = 2.0 mAdc, V _{CB} = 6.0 Vdc, f = 31.9 MHz)	rb′C _C	3.0	14	ps
Noise Figure (See Figure 1) (I _C = 1.5 mAdc, V _{CE} = 6.0 Vdc, R _S = 50 ohms, f = 200 MHz)	NF	-	5.0	dB
Common-Emitter Amplifier Power Gain (See Figure 1) (V _{CE} = 6.0 Vdc, I _C = 5.0 mAdc, f = 200 MHz)	G _{pe}	15	_	dB

⁽¹⁾ f_T is defined as the frequency at which $|h_{\mbox{\scriptsize fe}}|$ extrapolates to unity.

FIGURE 1 – 200 MHz AMPLIFIER POWER GAIN AND NOISE FIGURE CIRCUIT



- L1 1-3/4 Turns, #18 AWG, 0.5" L, 0.5" Diameter
- L2 2 Turns, #16 AWG, 0.5" L, 0.5" Diameter
- L3 2 Turns, #13 AWG, 0.25" L, 0.5" Diameter (Position 1/4" from L2)

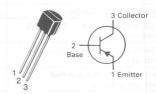
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	54V -15	Vdc
Collector-Base Voltage	V _{CBO}	50V -15	Vdc
Emitter-Base Voltage	VEBO	-4.5	Vdc
Collector Current — Continuous	Ic	50	mA
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	Watts mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

THE THE STEP HE STEP H			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

MPS5771

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



SWITCHING TRANSISTOR

PNP SILICON

Characteristic Lhafton work	Symbol	Min	Max	Unit
OFF CHARACTERISTICS AND TOTAL	Admin a distribu	alÇi		
Collector-Emitter Breakdown Voltage (I _C = −3.0 mA)(1)	V(BR)CEO	- 15	2011-777	Vdc
Collector-Emitter Breakdown Voltage ($I_C = -100 \mu A$)	V(BR)CES	- 15	masu of H	Vdc
Collector-Base Breakdown Voltage ($I_C = -100 \mu A$)	V(BR)CBO	- 15	4_10	Vdc
Emitter-Base Breakdown Voltage ($I_E = -100 \mu A$)	V(BR)EBO	-4.5	WO.U. 15	Vdc
Collector Cutoff Current (V _{CB} = -8.0 Vdc)	ICBO	_	-10	nA
Collector Cutoff Current $(V_{CE} = -8.0 \text{ Vdc})$ $(V_{CE} = -8.0 \text{ Vdc}, T_{A} = 125^{\circ}\text{C})$	ICES	_	- 10 - 5.0	nA μA
Emitter Cutoff Current (V _{EB} = -4.5 Vdc)	I _{EBO}	_	-1.0	μΑ
ON CHARACTERISTICS			financii O. Ni	VI. 17.00
DC Current $(I_C = -1.0 \text{ mA}, V_{CE} = -0.5 \text{ Vdc})(1)$ $(I_C = -10 \text{ mA}, V_{CE} = -1.0 \text{ Vdc})(1)$ $(I_C = -50 \text{ mA}, V_{CE} = -1.0 \text{ Vdc})(1)$ $(I_C = -10 \text{ mA}, V_{CE} = -1.0 \text{ Vdc}, T_A = -55^{\circ}\text{C})$	hFE	30 35 25 15	120 —	IATIAHO MC
Collector-Emitter Saturation Voltage(1)	VCE(sat)	Del Waren		Vdc

$(I_C = -10 \text{ mA}, V_{CE} = -1.0 \text{ Vdc})(1)$		35	120	
$(I_C = -50 \text{ mA}, V_{CE} = -1.0 \text{ Vdc})(1)$ $(I_C = -10 \text{ mA}, V_{CE} = -1.0 \text{ Vdc}, T_{\Delta} = -55^{\circ}\text{C})$		25 15		
Collector-Emitter Saturation Voltage(1) (Ic = -1.0 mA, I _B = -0.1 mA) (I _C = -1.0 mA, I _B = -1.0 mA) (I _C = -50 mA, I _B = -5.0 mA)	VCE(sat)	PSIA THE	-0.15 -0.18 -0.6	Vdc
Base-Emitter Saturation Voltage(1) (I _C = -1.0 mA, I _B = -0.1 mA) (I _C = -10 mA, I _B = -1.0 mA) (I _C = -50 mA, I _B = -5.0 mA)	V _{BE} (sat)		-0.8 -0.95 -1.5	Vdc

SMALL-SIGNAL CHARACTERISTICS				
Collector-Base Capacitance (V _{CB} = -5.0 Vdc, f = 140 kHz, f = 1.0 MHz)	C _{cb}	63/ 18 (257)	3.0	pF. _{MB}
Emitter-Base Capacitance (V _{EB} = -0.5 Vdc, f = 140 kHz, f = 1.0 MHz)	C _{eb}	17 0.6	3.5	pF
Small-Signal Current Gain	be-	8.5		CONTRACTOR OF THE PARTY OF THE

SWITCHING CHARACTERISTICS

 $(I_C = -10 \text{ mA}, V_{CE} = -10 \text{ Vdc}, f = 100 \text{ MHz})$

Turn-On Time	$(V_{CC} = -1.5 \text{ Vdc, I}_{C} = -10 \text{ mAdc,}$ $I_{B} = -1.0 \text{ mA})$	ton	_	15	ns
Delay Time		t _d	_	10	ns
Rise Time		t _r	_	15	ns
Turn-Off Time	$(V_{CC} = -1.5 \text{ V, I}_{C} = -10 \text{ mA,}$ $I_{B1} = I_{B2} = -1.0 \text{ mA})$	toff	_	20	ns
Fall Time		tf	_	10	ns
Storage Time	$(V_{CC} = -1.5 \text{ V}, I_C = -10 \text{ mA}, I_{B1} \approx I_{B2} \approx -10 \text{ mA})$	t _S	-	20	ns

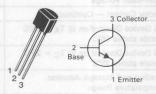
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	50	Vdc
Collector-Base Voltage	VCBO	60	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	IC	200	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	O° 6 TO

THERMAL CHARACTERISTICS

THEMMAL CHAMACTERISTICS			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta,IC}$	83.3	°C/W

MPS6428

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

Cha	aracteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	ORDINATV	(1)(A	In 0.8 3.0 m	epatioV nwo	tolse:Breddi	n3-rotoslio
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	BBD(BB)V	(A	V _(BR) CEO	50	nitus — enkd	Vdc
Collector-Base Breakdown Voltage (I _C = 0.1 mAdc, I _E = 0)	Osa(ea)V		V _(BR) CBO	60	nwap i saati	Vdc
Collector Cutoff Current (VCE = 30 Vdc)	680		ICES	30 A)	0.025	μΑ
Collector Cutoff Current (VCB = 30 Vdc, I _E = 0)	OB2 ¹	13.6	ІСВО	190V 18- = 83V	0.01	μΑ
Emitter Cutoff Current			IEBO		0.01	μΑ
(V _{EB} = 5.0 Vdc, I _C = 0)	.390		(P)(65V 2.0 -	= and Am	0.7 = -1.0	tnersu3.3
ON CHARACTERISTICS			(TROBV D.I -	= 30V (Am	100 = -101	
DC Current Gain ($V_{CE} = 5.0 \text{ Vdc}, I_{C} = 0.01 \text{ mAdc}$) ($V_{CE} = 5.0 \text{ Vdc}, I_{C} = 0.1 \text{ mAdc}$) ($V_{CE} = 5.0 \text{ Vdc}, I_{C} = 1.0 \text{ mAdc}$) ($V_{CE} = 5.0 \text{ Vdc}, I_{C} = 10 \text{ mAdc}$)			hFE	250 250 250 250	650 —	3-1000elle (lg = -1 (lg = -1
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 0.5 mAdc) (I _C = 100 mAdc, I _B = 5.0 mAdc)	Vertuen	10 = -0.1 mA) 10 = -1.0 mA)	VCE(sat)	(f)agetloV	0.2 0.6	Vdc
Base-Emitter On Voltage (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc)		IAM Cat - + g	V _{BE(on)}	0.56	0.66	Vdc
SMALL-SIGNAL CHARACTERISTICS	do ²				nial Capital an	allactor-Ba
Current-Gain — Bandwidth Product (I _C = 1.0 mAdc, V _{CE} = 5.0 V, f = 1	00 MHz)		fT	100	700	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz) (1)		C _{obo}	n Cales De	3.0	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MH	z)		C _{ibo}	eortar	8.0	pF
16 /19	no)				niT nO-mi	
	67					
	45					
	theil					
	10					

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
Input Impedance (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz)	amu	Vishia	h _{ie}	3.0	30	kΩ
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz)	Way.	05	h _{re}	2.0	20	X 10-4
Small-Signal Current Gain (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	St. 17	0.F 0.a	os h _{fe}	200	800	osse land Judge Car
Output Admittance (I _C = 1.0 mAdc, V _{CF} = 5.0 Vdc, f = 1.0 kHz)	V/m or w/m	255 A.2	h _{oe}	5.0	50	μmhos

NOISE FIGURE/TOTAL NOISE VOLTAGE CHARACTERISTICS

	NF	VT	NF	VT	NF	VT	oute alon	
	Max	k (1)	Ma	x (2)	Max	x (3)	U	nit
Noise Figure/Voltage (V _{CE} = 5.0 V, I _C = 0.1 mA, T _A = 25°C)	7.0	18.1	6.0	5700	3.5	4.3	dB	nV

⁽¹⁾ $R_S = 10 \text{ k}\Omega$, BW = 1.0 Hz, f = 100 Hz(2) $R_S = 50 \text{ k}\Omega$, BW = 15.7 kHz, f = 10 Hz - 10 kHz(3) $R_S = 500 \Omega$, BW = 1.0 Hz, f = 10 Hz

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	20	Vdc
Collector-Base Voltage	VCBO	30	Vdc
Emitter-Base Voltage	VEBO	3.0	Vdc
Collector Current — Continuous	Ic	50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

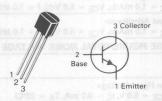
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

(1) $R_{ heta JA}$ is measured with the device soldered into a typical printed circuit board.

MPS6507

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I _C = 1.0 mAdc, I _B = 0)	V(BR)CEO	20	-	-	Vdc
Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0)	V(BR)CBO	30			Vdc
Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0)	V(BR)EBO	3.0	-	-	Vdc
Collector Cutoff Current (V _{CB} = 15 Vdc, I_E = 0) (V _{CB} = 15 Vdc, I_E = 0, T_A = 60°C)	ІСВО	=	=	50 1.0	nAdc μAdc
ON CHARACTERISTICS					
DC Current Gain(2) (I _C = 2.0 mAdc, V _{CE} = 10 Vdc)	hFE	25	75	-	-
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	fT	700	800	-	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}		1.25	2.5	pF
Small-Signal Current Gain (I _C = 2.0 mAdc, V _{CE} = 10 Vdc, f = 20 MHz)	h _{fe}	20	-	-	

(2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Rating	Symbol	NPN	PNP	Unit
Collector-Emitter Voltage	VCEO			Vdc
MPS6520, MPS6521		25	_	
MPS6523		_	25	
Collector-Base Voltage	V _{CBO}			Vdc
MPS6520, MPS6521		40	_	
MPS6523		_	25	
Emitter-Base Voltage	V _{EBO}	4.0		Vdc
Collector Current — Continuous	Ic	100		mAdc
Total Device Dissipation @ T _Δ = 25°C	PD	6	25	mW
Derate above 25°C		5	.0	mW/°C
Total Device Dissipation @ T _C = 25°C	PD	1.5		Watts
Derate above 25°C		abV 1	2	mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient (Printed Circuit Board Mounting)	$R_{\theta}JA$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

NPN MPS6520 MPS6521*



PNP⁽¹⁾ MPS6523



CASE 29-04, STYLE 1 TO-92 (TO-226AA)

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AMPLIFIER TRANSISTORS

★This is a Motorola designated preferred device.

Refer to MPS3904 for NPN graphs. Refer to 2N5086 for PNP graphs.

Chara	acteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				- Portional	Asserted to 190
Collector-Emitter Breakdown Voltage (I _C = 0.5 mAdc, I _B = 0)	033(88)	V(BR)CEO	25	O gT.ma	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	OBTIGUE	V _{(BR)EBO}	4.0	0 = = 1	Vdc
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0) (V _{CB} = 20 Vdc, I _E = 0)	MPS6520,MPS6521 MPS67523	I _{CBO}	- Spano	0.05 0.05	μAdc
ON CHARACTERISTICS			TO THE - BOYCE	(U × 31 311-	N = RUV)
DC Current Gain $(I_{C} = 100 \ \mu \text{Adc}, V_{CE} = 10 \ \text{Vdc})$ $(I_{C} = 2.0 \ \text{mAdc}, V_{CE} = 10 \ \text{Vdc})$ $(I_{C} = 100 \ \mu \text{Adc}, V_{CE} = 10 \ \text{Vdc})$ $(I_{C} = 100 \ \mu \text{Adc}, V_{CE} = 10 \ \text{Vdc})$ $(I_{C} = 2.0 \ \text{mAdc}, V_{CE} = 10 \ \text{Vdc})$ Collector-Emitter Saturation Voltage $(I_{C} = 50 \ \text{mAdc}, I_{R} = 5.0 \ \text{mAdc})$	MPS6520 MPS6521 MPS6520 MPS6521 MPS6523 MPS6523	hFE VCE(sat)	100 150 200 300 150 300	400 600 — 600 0.5	ASSATE MO
SMALL-SIGNAL CHARACTERISTICS	WESHER1		COMPARTO O	- Br - m	- 30
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	Neset V	C _{obo}	Systic (abAna 0	3.5	pF
Noise Figure (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc, R _S = Power Bandwidth = 15.7 kHz, 3.0 dB		NF	Spitania.	3.0	dB Mg

^{*}Refer to 2N5086 for PNP graphs.

⁽¹⁾ Voltage and Current are negative for PNP Transistors.

NPN 3 Collector MPS6520 Pose Collector Pose Collect

MAXIMUM RATINGS

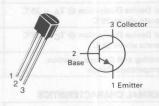
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	VCBO	60	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	Ic	600	mAdo
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625	mW
Junction Temperature	TJ, T _{stg}	150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	Rela	0.2	°C/mW

MPS6530 MPS6531

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N4400 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Cha	racteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	- sandy		William Springer		a new pages we	AGAMA S
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	OBD(RB)V		V(BR)CEO	40	ifter Breakdr	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0)	Овајяві		V(BR)CBO	60	gwabilatiili (6 – al al A	Vdc
Emitter-Base Breakdown Voltage (I _B = 10 µAdc, I _C = 0)	080	10733300.4 (0)	V(BR)EBO	5.0	meriod her	Vdc
Collector Cutoff Current (V _{CB} = 40 Vdc, I _E = 0) (V _{CB} = 40 Vdc, I _E = 0, T _A = 60° C)		883	СВО	=	0.05 2.0	μAdc
ON CHARACTERISTICS	建		Sentral and	Total No.	DIER	Anima and t
DC Current Gain (I _C = 10 mAdc, V_{CE} = 1.0 Vdc) (I _C = 100 mAdc, V_{CE} = 1.0 Vdc)		MPS6530	hFE	30 60 40 90	120 270	10 = 2.0 1c = 100
(I _C = 500 mAdc, V_{CE} = 10 Vdc)			SSEMM	25 50	- 30 - sbAri	
Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 10 mAdc)	(/68)307	MPS6530 MPS6531	VCE(sat)	0 mAde) TERISTICS	0.5 0.3	Vdc
Base-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 10 mAdc)	Copo		V _{BE} (sat)	1 = 1.0 MHb	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS	4/4		and a Ka	-0 -10-0 0	= ====	mugird easi
Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz)	(sHst 0) has sh	C _{obo}	16 0.0 1 /10 0.0	5.0	pF

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	25	Vdc
Collector-Base Voltage	VCBO	₂₅ 25	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	Ic	500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C -

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	200	°C/mW
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/mW

(1) $R_{ heta JA}$ is measured with the device soldered into a typical printed circuit board.



Chara	cteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				7 1.53	TUARANO T
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0)	OTT BIY	V(BR)CEO	25	0 - 1 0 - 1	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	Mayer	V(BR)CBO	25	(U s)	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μ Adc, I _C = 0)	Varieso	V(BR)EBO	5.0	(0 = 0)	Vdc
Collector Cutoff Current (V _{CE} = 25 Vdc, I _B = 0)	oan ^t	ICES	_	100	nAdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0)	200	ІСВО	_	100	nAdc
Emitter Cutoff Current (VEB(off) = 4.0 Vdc, I _C = 0)		I _{EBO}	<u>⊢</u> √ 0.	100	nAdc
ON CHARACTERISTICS(1)	1975) 400		cresAcr	70.E	itai Ut = 5
DC Current Gain (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 1.0 Vdc)	[ELEGI]	hFE	35 50 50	200	m 11 - 3- m 12 - 5
Collector-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc)		VCE(sat)	1 Vale 1	0.5	Vdc
Base-Emitter On Voltage (I _C = 500 mAdc, V _{CE} = 1.0 Vdc)		VBE(on)	allo u t -	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS	3.11	A SHOUND	L Links 0		12.00
Current-Gain — Bandwidth Product $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 20)$	MHz)	fT	60	1-	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}	I - TITO DO	30	pF

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μs , Duty Cycle \leq 2.0%.

⁽²⁾ Voltage and Current are negative for PNP Transistors.

THE BELLIT THE TELL THE BELLIT TH			
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	20	Vdc
Collector-Base Voltage	VCBO	20	Vdc
Emitter-Base Voltage	VEBO	3.0	Vdc
Collector Current — Continuous	lc	50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	- 01°C

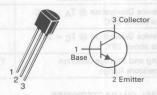
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case(1)	$R_{\theta JC}$	125	°C/W

(1) $R_{ heta JA}$ is measured with the device soldered into a typical printed circuit board.

MPS6568A

CASE 29-04, STYLE 2 TO-92 (TO-226AA)



VHF TRANSISTOR

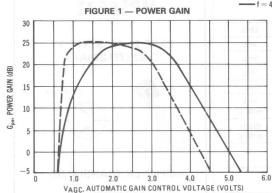
NPN SILICON

Characteristic Symbol Min Max Unit

tinU Char	acteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	Oaciaaly	V(BR)CEO	20	er 8r⊈kdavyr dc. Ig = 0)	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	V(BB)CBO	V(BR)CBO	20	Creekdown (do, (g = 0)	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)	ORS(NO)V	V(BR)EBO	3.0	ov naedden Ve de, te = 01	
Collector Cutoff Current (VCB = 10 Vdc, IC = 0)	esol	ІСВО	_	50 0 1 10 = gl sib	nAdc
ON CHARACTERISTICS	oea!			menu3 l	toniO rom
DC Current Gain (I _C = 4.0 mAdc, V _{CE} = 5.0 Vdc)	eao	hFE	20	200	Post Surph
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 5.0 mAdc)		VCE(sat)	0.1	3.0	Vdc
Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 5.0 mAdc)	344	V _{BE} (sat)	(spV c	0.96	Vdc
SMALL-SIGNAL CHARACTERISTICS			John D.	# 90V JOE	ATT DUT =
Current-Gain — Bandwidth Product (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 1	00 MHz)	fT	375	800	MHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz,	emitter guarded)	C _{cb}	- Cabat D	0.65	pF
Noise Figure (VAGC = 1.4 Vdc, RS = 50 ohms, f =	200 MHz)	NF	aomain	3.3	dB
FUNCTIONAL TEST	TOTAL		Toubor -	HISTORIAN AND AND AND AND AND AND AND AND AND A	Am Af -
Amplifier Power Gain (VAGC = 1.4 Vdc, R _S = 50 ohms, f =	200 MHz)	G _{pe}	20	27	dB
Forward AGC Voltage (Gain Reduction = 30 dB, R _S = 50 of	ıms, f = 200 MHz)	VAGC	4.0	5.0	Vdc

AGC CHARACTERISTICS

 $V_{CC} = 12 \, \text{Vdc}, \, R_S = 50 \, \text{OHMS}, \, \text{SEE FIGURES 9 AND } 10$



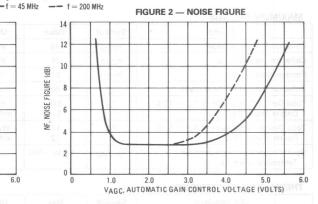
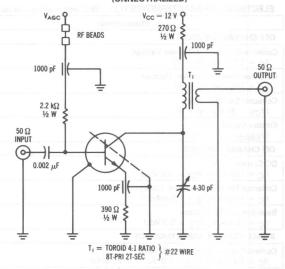


FIGURE 3 — 200 MHz FUNCTIONAL TEST CIRCUIT

(NEUTRALIZED) V_{CC} = 12 V ♥ VAGC P = 12 270 Ω W \} 2.2 kΩ } 1000 pF 1000 pF 50 Ω OUTPUT (0) 820 pF 0.7-10 pF 50 Ω INPUT (0) 820 pF 1000 pF 390 Ω 1/2 W T_I = FERRITE CORE INDIANA GEN. CORP. F-684

 $T_2 = 6$ TURNS #16 BUSS WIRE, ID = $\frac{1}{4}$ ", L = $\frac{3}{4}$ ".

FIGURE 4 — 45 MHz FUNCTIONAL TEST CIRCUIT (UNNEUTRALIZED)



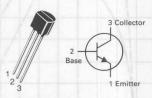
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	20	Vdc
Collector-Base Voltage	VCBO	25	Vdc
Emitter-Base Voltage	VEBO	3.0	Vdc
Collector Current — Continuous	IC	50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

THE HIMAE OHAHAOTE HIOTIOO			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	R _θ JC	83.3	°C/W

MPS6571

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPSA18 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	4	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	7		S Wat .		3	M.St.
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	All surrous	V(BR)CEO	20	_	H	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc$, $I_E = 0$)	THE STATE OF THE S	V _(BR) CBO	25	07.10	T til	Vdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0)	0122	ІСВО	江下	340 I	50	nAdc
Emitter Cutoff Current (VEB(off) = 3.0 Vdc, I _C = 0)	() () () () () () () () () () () () () (IEBO	5	08-Y.0— 2	50	nAdc
ON CHARACTERISTICS	460		1/1)		-11-6
DC Current Gain (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc)	Registra T	hFE	250	<-	1000	3g 0S 3.
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)		V _{CE(sat)}	-) - <u>1-</u> noar	-	0.5	Vdc
Base-Emitter On Voltage (I _C = 10 mAdc, V _{CE} = 5.0 Vdc)		V _{BE(on)}	A HINE	-	0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS	+ +	*	幸	+		
Current-Gain — Bandwidth Product (I _C = 500 μ Adc, V _{CE} = 5.0 Vdc, f = 20 MHz)		fT	50	175	1, = 1 mil a = 1.1	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}	-	-	4.5	pF
Noise Figure (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 kohms,	f = 100 Hz)	NF	-	1.2	-	dB

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	12	Vdc
Emitter-Base Voltage	VEBO	3.0	Vdc
Collector Current — Continuous	Ic	50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.81	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

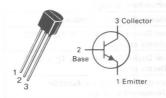
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

MPS6595*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Characte	ristic	Jerran saw	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	lodany.			dehatostari			11.00
Collector-Emitter Breakdown Voltage(2 (I _C = 1.0 mAdc, I _B = 0)	2)		V(BR)CEO	12	Cawn Vellege	ot sl <u>ed</u> que de la com	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc$, $I_E = 0$)		APSBROTZBOST APSBROZ RESZ	V(BR)CBO	20	- 18	- pl <u>su</u> 11	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)	otome/*	1888/108824A	V(BR)EBO	3.0	apa <u>llu</u> v (w.	on i <u>il</u> i i sa si ili ili ili ili	Vdc
Collector Cutoff Current (V _{CB} = 15 Vdc, I _E = 0)	nalvegiV	200012(0002111)	ICBO	_	ep. Nov n	100	nAdc
Emitter Cutoff Current (V _{EB} = 2.5 Vdc, I _C = 0)			IEBO		- (6)	1.0	μAdc
ON CHARACTERISTICS		000 - 0000 - A	•		10	er ski di	9377
DC Current Gain (I _C = 10 mAdc, V_{CE} = 5.0 Vdc) (I _C = 50 mAdc, V_{CE} = 5.0 Vdc)	(155)	APS 6501.8651	hFE	25 20	= 10	250 230	(V _{CC} = 1
SMALL SIGNAL CHARACTERISTICS						carl and the	AARO M
Current-Gain — Bandwidth Product $(I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc}, f =$	100 MHz)		fT	1200	tops pr	THE	MHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, f = 1.0 MHz)			C _{cb}	_	Into A	1.3	pF

(2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage MPS6601/6651 MPS6602/6652	VCEO	25 40	Vdc
Collector-Base Voltage MPS6601/6651 MPS6602/6652	VCBO	25 30	Vdc
Emitter-Base Voltage	VEBO	4.0	Vdc
Collector Current — Continuous	IC	1000	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W

(1) R_{ØJA} is measured with the device soldered into a typical printed circuit board.

NPN MPS6601 MPS6602*



PNP⁽¹⁾ MPS6651 MPS6652*



CASE 29-04, STYLE 1 TO-92 (TO-226AA)

> AMPLIFIER TRANSISTORS

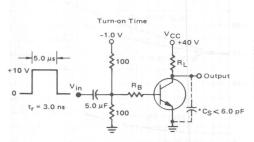


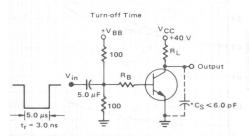
★These are Motoroladesignated preferred devices.

	Characteristic			Symbol	Min	Max	Unit
OFF CHARACTERISTICS	St n	inina)V		(2)	own Vertage	toleanS rattin	Collector-Er
Collector-Emitter Breakdown Vol (I _C = 1.0 mAdc, I _B = 0)	tage	У(вя)с	MPS6601/6651 MPS6602/6652	V(BR)CEO	25 40	mAdo, Ig = lee B re ukdos ,Ad o, Ig =	Vdc
Collector-Base Breakdown Volta ($I_C = 100 \mu Adc, I_E = 0$)	ge o.c. or	(88)V	MPS6601/6651 MPS6602/6652	V(BR)CBO	25 40	s Breakdown oldo , i c = C	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)		UUU!		V _{(BR)EBO}	4.0	= gl u bV 6	Vdc
Collector Cutoff Current (V _{CE} = 25 Vdc, I _B = 0) (V _{CE} = 30 Vdc, I _B = 0)		003	MPS6601/6651 MPS6602/6652	ICES	- (0	0.1 0.1	μAdc
Collector Cutoff Current (V _{CB} = 25 Vdc, I _E = 0) (V _{CB} = 30 Vdc, I _E = 0)	28	aan	MPS6601/6651 MPS6602/6652	СВО	5.0 Vde) 5.0 Vdc)	0.1 0.1	μAdc
ON CHARACTERISTICS					CALL GRADIO	AMERICA ARE	DIS JUPUNS
DC Current Gain (I _C = 100 mAdc, V _{CE} = 1.0 V (I _C = 500 mAdc, V _{CE} = 1.0 V (I _C = 1000 mAdc, V _{CE} = 1.0 V	dc)	Cob		hFE	50 50 30		Collector-Ba (VCB = 10 i
Collector-Emitter Saturation Volt (I _C = 1000 mAdc, I _B = 100 m				VCE(sat)	au (200) = 1	0.6	Vdc
Base-Emitter On Voltage (I _C = 500 mAdc, V _{CE} = 1.0 V	dc)			V _{BE(on)}	-	1.2	Vdc
SMALL-SIGNAL CHARACTERIS	rics						
Current-Gain — Bandwidth Prod (I _C = 50mAdc, V _{CE} = 10 Vdc				fT	100	1 -	MHz
Output Capacitance $(V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1.$	0 MHz)			C _{obo}	-	30	pF
SWITCHING CHARACTERISTICS							
Delay Time	THE BUSH WAS			^t d		25	ns
	= 40 Vdc, I _C = 500 = 50 mAdc,	mAdc,		t _r	-	30	ns
	300 ns Duty Cycle)			t _S	_	250	ns
Fall Time				tf		50	ns

⁽¹⁾ Voltage and Current are negative for PNP Transistors.

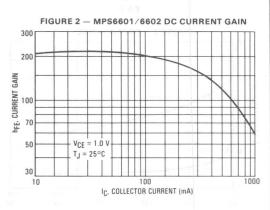
FIGURE 1 - SWITCHING TIME TEST CIRCUITS



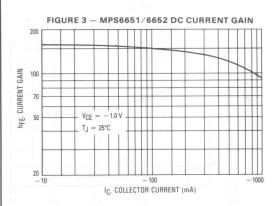


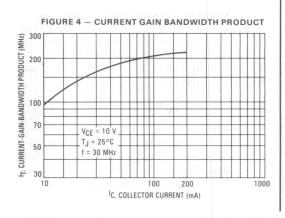
*Total Shunt Capacitance of Test Jig and Connectors For PNP Test Circuits, Reverse All Voltage Polarities

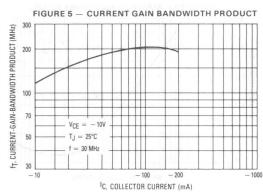
NPN

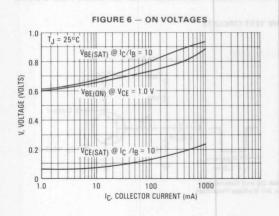


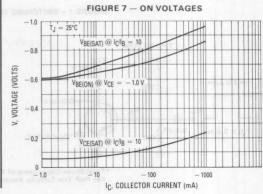
PNP

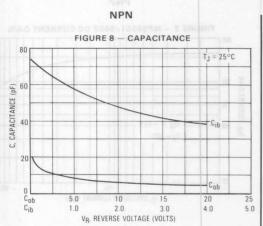


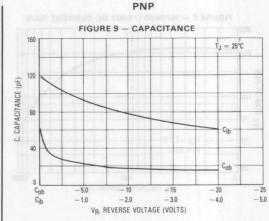


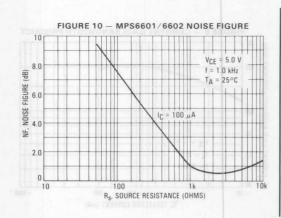












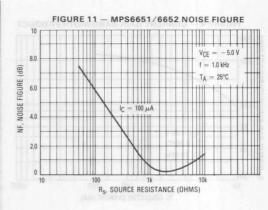
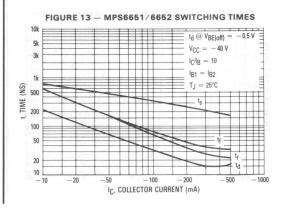
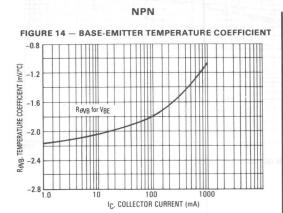
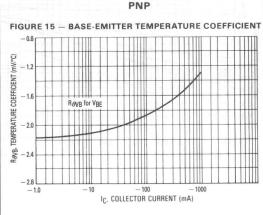
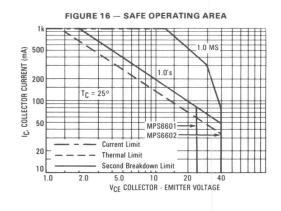


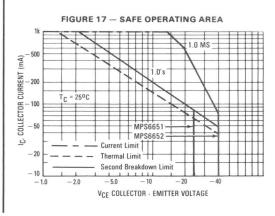
FIGURE 12 - MPS6601/6602 SWITCHING TIMES 10k t_d @ V_{BE(off)} = 0.5 V 5k $V_{CC} = 40 \text{ V}$ 3k $I_C/I_B = 10$ $I_{B1} = I_{B2}$ 1k T_J = 25°C t, TIME (NS) 500 200 100 50 10 10 20 IC. COLLECTOR CURRENT (mA)

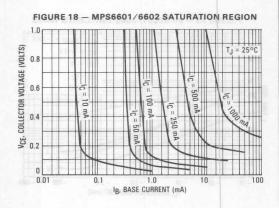


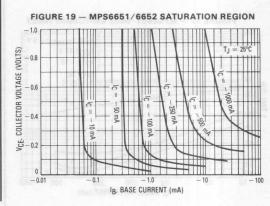


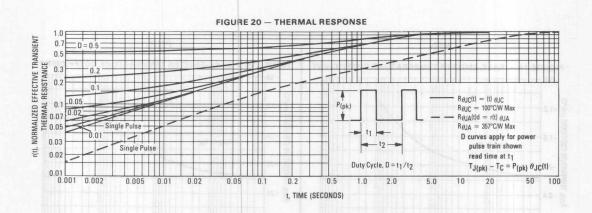












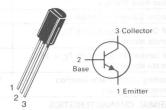
Rating	Symbol	Value	Unit
Collector-Emitter Voltage MPS6714 MPS6715	VCEO	30 40	Vdc
Collector-Base Voltage MPS6714 MPS6715	VCBO	40 50	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	Ic	1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

THE TWINE OF A TANGET OF THE THE						
Characteristic	Symbol	Max	Unit			
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W			
Thermal Resistance, Junction to Case	$R_{\theta}JC$	50	°C/W			

MPS6714 MPS6715

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPSW01 for graphs.

Chara	acteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					E 11 - 311	PE CHARU
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0)	OGDI IV	MPS6714 MPS6715	V(BR)CEO	30 40		Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \ \mu Adc, I_E = 0$)	Nustration and	MPS6714 MPS6715	V(BR)CBO	40 50	10 - C	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μ Adc, I _C = 0)	10.13		V(BR)EBO	5.0	108 <u></u> 011	Vdc III
Collector Cutoff Current $(V_{CB} = 40 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = 50 \text{ Vdc}, I_{E} = 0)$	0,63	MPS6714 MPS6715	ІСВО	=	0.1 0.1	μAdc
Emitter Cutoff Current (VEB = 5.0 Vdc, I _C = 0)		-	IEBO	Johy D	0.1	μAdc
ON CHARACTERISTICS(1)				1.6 Vde	1907	0c = 2200
DC Current Gain (I _C = 100 mAdc, V_{CE} = 1.0 Vdc) (I _C = 1000 mAdc, V_{CE} = 1.0 Vdc)	TINE		hFE	60 50	 250	(IC - 2 Interests)
Collector-Emitter Saturation Voltage (I _C = 1000 mAdc, I _B = 100 mAdc)			V _{CE(sat)}	2002BB	0.5	Vdc
Base-Emitter On Voltage (I _C = 1000 mAdc, V _{CE} = 1.0 Vdc)	TIGO .		V _{BE(on)}	- 1.0 MHz	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					36.1.11	Lui3-llemi
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)			C _{cb}	Bur Velor F	30	pF 5/1
Small-Signal Current Gain (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 20	MHz)		h _{fe}	2.5	25	_

⁽¹⁾ Pulse Test: Pulse Width \leq 30 μ s, Duty Cycle \leq 2.0%.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	80	Vdc
Collector-Base Voltage	VCBO	80	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	I _C	500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	50	°C/W

MPS6717

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPSW05 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Chara	acteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					SOUTH ST	TARBARA R
Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0)	сто(яв)сто	MASSAM	V(BR)CEO	80	vetolisare sa Un = wt sis	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	onsygmV		V(BR)CBO	80	mine) leave	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)		MPS6714 MPS6715	V(BR)EBO	5.0	(d) = oh/	Vdc
Collector Cutoff Current (VCB = 60 Vdc, IE = 0)	овзіявіУ		ICBO	-spate	0.1	μAdc
Emitter Cutoff Current (VEB = 5.0 Vdc, I _C = 0)	CBO	MP30714	IEBO	-	10	μAdc
ON CHARACTERISTICS		MPBG715			10 = 31 00) DS = 80
DC Current Gain (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) (I _C = 250 mAdc, V _{CE} = 1.0 Vdc)	083		h _{FE}	80 50	250	Her Duros Frg. = 5.0 CHARACT
Collector-Emitter Saturation Voltage (I _C = 250 mAdc, I _B = 10 mAdc)	gad		V _{CE(sat)}	(55V-0.1	0.5	Vdc
Base-Emitter On Voltage (I _C = 250 mAdc, V _{CE} = 1.0 Vdc)	(rex)93V		V _{BE(on)}	1.0 <u>Vø</u> e) n Voltage	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS				(shAm GD)	≈ gl. st.An	0000 = 0
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	(no)38V		C _{cb}	HaV 0.1 i	30	pF
Small-Signal Current Gain (I _C = 200 mAdc, V _{CE} = 5.0 Vdc, f = 1	20 MHz)		h _{fe}	2.5	25	ADIR-LIA ass8-actor
Pulso Tost: Pulso Width - 300 Duty Cyal				HARRIED TO THE	The of all	Ant - No

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

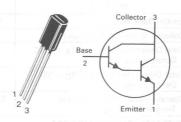
Rating	Symbol	MPS6724	MPS6725	Unit
Collector-Emitter Voltage	VCES	40	50	Vdc
Collector-Base Voltage	V _{CBO}	50	60	Vdc
Emitter-Base Voltage	VEBO	1	2	Vdc
Collector Current — Continuous	IC	1000		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20		Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

MPS6724 MPS6725

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



ONE WATT DARLINGTON TRANSISTORS

NPN SILICON

Refer to 2N6426 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
OFF CHARACTERISTICS					21 IT.	ARAHO TH
Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0)	CIPLISH	MPS6724 MPS6725	V(BR)CES	40 50	000 0000 	Vdc
Collector-Base Breakdown Voltage (I _C = 1.0 μ Adc, I _E = 0)	CHOIL IN	MPS6724 MPS6725	V(BR)CBO	50 60		Vdc Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	Udan 19		V _{(BR)EBO}	12	1 1 - 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Vdc
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0) (V _{CB} = 40 Vdc, I _E = 0)	Oall	MPS6724 MPS6725	ІСВО	_	100 100	nAdc
Emitter Cutoff Current (VEB = 10 Vdc, I _C = 0)			IEBO		100	nAdc
ON CHARACTERISTICS(1)					RECORD	IN CHARAC
DC Current Gain (I _C = 200 mAdc, V_{CE} = 5.0 Vdc) (I _C = 1000 mAdc, V_{CE} = 5.0 Vdc)	ATT		hFE	25,000 4,000	40,000	0 (و <u>سم</u> د الله (اور الله الله الله (اور الله الله الله
Collector-Emitter Saturation Voltage (I _C = 1000 mAdc, I _B = 2.0 mAdc)	- Flägt		V _{CE(sat)}	sg <u>-tt</u> aV m plua QUI	1.5	Vdc
Base-Emitter On Voltage (I _C = 1000 mAdc, V _{CE} = 5.0 Vdc)	(au) 18		V _{BE(on)}	W07:	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				enismos	CINE III	MALLS SICN
Current-Gain — Bandwidth Product (I _C = 200 mAdc, V _{CE} = 5.0 Vdc, f =	100 MHz)		fT	100	1000	MHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	1917		C _{cb}	- UV 01 -	10	pF

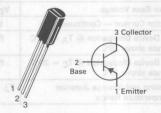
Rating	Symbol	Value	Unit
Collector-Emitter Voltage MPS6726 MPS6727	VCEO	-30 -40	Vdc
Collector-Base Voltage MPS6726 MPS6727	VCBO	-40 -50	Vdc
Emitter-Base Voltage	V _{EBO}	-5.0	Vdc
Collector Current — Continuous	Ic	-1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	R_{θ} JA	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

MPS6726 MPS6727

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

PNP SILICON

Refer to MPSW51 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

MinU xall Chara	cteristic	Hereign to the second	Symbol	Min Min	Max	Unit
OFF CHARACTERISTICS	1077				SOFTERET	IFF CHARAGE
Collector-Emitter Breakdown Voltage (I _C = -10 mAdc, I _B = 0)	VIBRICES	MPS6726 MPS6727	V(BR)CEO	-30 -40	ter Breskdow Adc. is. = 0)	
Collector-Base Breakdown Voltage ($I_C = -100 \mu Adc, I_E = 0$)	Verticed	MPS6726 MPS6727	V(BR)CBO	-40 -50	Grasidown Ndc. I _C = 0)	
Emitter-Base Breakdown Voltage ($I_E = -100 \mu Adc, I_C = 0$)	OBS(RB)V		V(BR)EBO	-5.0	Break d awn Vo do, ic = 0)	Vdc
Collector Cutoff Current (VCB = -40 Vdc, I _E = 0) (VCB = -50 Vdc, I _E = 0)	OBOL	MPS6726 MPS6727	ICBO	_	-0.1 -0.1	
Emitter Cutoff Current (VEB = -5.0 Vdc, I _C = 0)	onal		I _{EBO}	-	-0.1 ₀ 0	μAdc
ON CHARACTERISTICS(1)					(FIRSTICS(1))	IN CHARAC
DC Current Gain (I _C = -100 mAdc, V _{CE} = -1.0 Vdc) (I _C = -1000 mAdc, V _{CE} = -1.0 Vdc)	aari .		hFE	60	1000	C Clamant S llc = 200 r (lc = 1000
Collector-Emitter Saturation Voltage (I _C = -1000 mAdc, I _B = -100 mAdc)	(leal)30¥		VCE(sat)	volume () mAdc)	- 0.5 - gl.abAm	Vdc
Base-Emitter On Voltage $(I_C = -1000 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})$			V _{BE(on)}	5.0 Vdc)	ag = 1.2 aq	Vdc
SMALL-SIGNAL CHARACTERISTICS				ENR DOS	AL CHARACT	VIDIR-LIAM
Collector-Base Capacitance $(V_{CB} = -10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz})$) 77		C _{cb}	Product 5.6 Vdc, f =	30 m = 30 V abAr	100 PF 100
Small-Signal Current Gain $(I_C = -50 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}, f = -10 \text{ Vdc})$	= 20 MHz)		h _{fe}	2.5	25 sol	es8-r uc oelle Of = 80V7

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

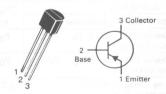
MAXIMUM RATINGS	T B II W	EEGEST	A SERVE
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-40	Vdc
Collector-Base Voltage	V _{CBO}	abV -40 08	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current — Continuous	Ic	-200	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW/°C
Total Device Dissipation @ T _C = 60°C	PD	450	mW
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

THE WINE OF A LACTERIO TIOS							
Characteristic	Symbol	Max	Unit				
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W				
Thermal Resistance, Junction to Case	Reic	83.3	°C/W				

MPS8093

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N4402 for graphs.

through the Mark Chara	acteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				835 415	T CHA D
Collector-Emitter Breakdown Voltage (I _C = -10 mAdc)	ODELEV V SEESS IN RECUENT	V(BR)CEO	- 40	10 - 11 16	Vdc
Collector-Base Breakdown Voltage ($I_C = -100 \mu Adc$)	AT SERVE MESSERVE V SRICING	V(BR)CBO	-40	Tini v - XTL	Vdc
Emitter-Base Breakdown Voltage (I _E = $-100 \mu Adc$)	MES ross, Mess au MESsoss, Mess au	V(BR)EBO	-5.0	A 2	Vdc
Collector Cutoff Current (V _{CB} = -20 V)	EPO-STAT BRUSSTAN	ICBO		- 100	nAdc
Emitter Cutoff Current (VEB = -3.0 V)	ROCK	IEBO	_	- 100	nAdc
ON CHARACTERISTICS					111
DC Current Gain (I _C = -50 mAdc, V _{CE} = -2.0 Vdc)	MPS8089 MPSS178	hFE	100	300	Voe −eoVi
Collector-Emitter Saturation Voltage ($I_C = -50 \text{ mAdc}$, $I_B = -5.0 \text{ mAdc}$)	MPsteas NPSses	VCE(sat)	_	-0.25	Vdc
Base-Emitter On Voltage (IC = -50 mAdc, V _{CF} = -2.0 V)	писления вервени	V _{BE(on)}	-0.6	-1.0	Vdc

Rating	Symbol	IMPS8098 IMPS8598	MPS8099 MPS8599	Unit
Collector-Emitter Voltage	VCEO	60	80	Vdc
Collector-Base Voltage	VCBO	60	80	Vdc
		MPS8099	MPS8598 MPS8599	20.31
Emitter-Base Voltage	VEBO	6.0	5.0	Vdc
Collector Current — Continuous	Ic	5	00	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watts mW/°C
Operating Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

NPN MPS8098 MPS8099*



PNP⁽²⁾ **MPS8598** MPS8599*



CASE 29-04, STYLE 1 TO-92 (TO-226AA)

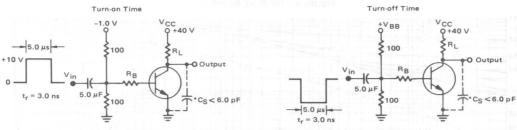


AMPLIFIER TRANSISTORS

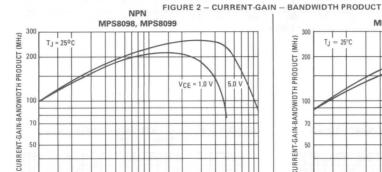
★These are Motorola designated preferred devices.

the state of the s	Chara	cteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS							
Collector-Emitter Breakdown (I _C = 10 mAdc, I _B = 0)	n Voltage(1)	Уверско	MPS8098, MPS8598 MPS8099, MPS8599	V(BR)CEO	60 80	er Brokdow Add)—	Vdc
Collector-Base Breakdown V	/oltage			V(BR)CBO		abea	Vdc
$(I_C = 100 \ \mu Adc, I_E = 0)$	0.8-	V(BR)EBO	MPS8098, MPS8598 MPS8099, MPS8599		60 80	edia cum Ve	er-Base 15 = - 100
Emitter-Base Breakdown Vo $(I_E = 10 \mu Adc, I_C = 0)$	ltage		MPS8098, MPS8099 MPS8598, MPS8599	V(BR)EBO	6.0 5.0	Current V)	Vdc
Collector Cutoff Current (VCE = 60 Vdc, IB = 0)		Ons		ICES	_	0.1	μAdc
Collector Cutoff Current $(V_{CB} = 60 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = 80 \text{ Vdc}, I_{E} = 0)$	100	390	MPS8098, MPS8598 MPS8099, MPS8599	СВО	- 2.0 <u>V</u> ac)	0.1 0.1	μAdc
Emitter Cutoff Current (V _{EB} = 6.0 Vdc, I _C = 0) (V _{EB} = 4.0 Vdc, I _C = 0)	8.0-	Vectors)	MPS8098, MPS8099 MPS8598, MPS8599	IEBO	sgullov (sb <u>Ar</u> n 0,8	0.1 0.1	μAdo
ON CHARACTERISTICS(1)					= 2.0 V)	= aoV abA	n 08 - =
	nAdc, V _{CE} = nAdc, V _{CE} = mAdc, V _{CE} =	5.0 Vdc)		hFE	100 100 75	300	
Collector-Emitter Saturation		= 100 mAdc, lg = 100 mAdc, lg		VCE(sat)		0.4 0.3	Vdc
Base-Emitter On Voltage ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 5 \text{ (}I_C = 10 \text{ mAdc}$, $V_{CE} = 5.0 \text{ mAdc}$)			MPS8098, MPS8098 MPS8099, MPS8599	V _{BE(on)}	0.5 0.6	0.7 0.8	Vdc
SMALL-SIGNAL CHARACTE	RISTICS						
Current-Gain — Bandwidth $(I_C = 10 \text{ mAdc}, V_{CE} = 5.$		00 MHz)		fT	150	_	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f	= 1.0 MHz)		MPS8098, MPS8099 MPS8598, MPS8599	C _{obo}	=	6.0 8.0	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f	= 1.0 MHz)		MPS8098, MPS8099 MPS8598, MPS8599	C _{ibo}	=	25 30	pF
) Pulse Test: Pulse Width < 300	Duty Cyale	- 2.00/		-			

FIGURE 1 - SWITCHING TIME TEST CIRCUITS



*Total Shunt Capacitance of Test Jig and Connectors For PNP Test Circuits, Reverse All Voltage Polarities



5.0 7.0 10

IC, COLLECTOR CURRENT (mA)

上

1.0

2.0 3.0

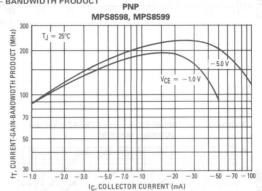
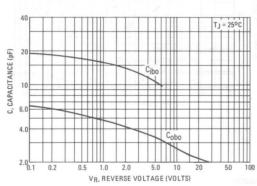


FIGURE 3 - CAPACITANCE

50 70 100



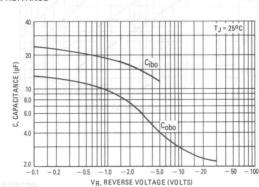
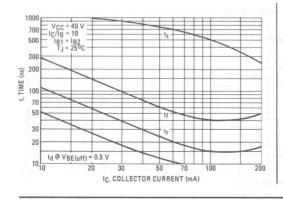
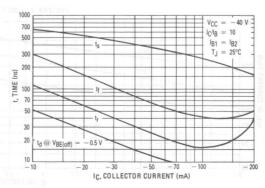


FIGURE 4 - SWITCHING TIMES





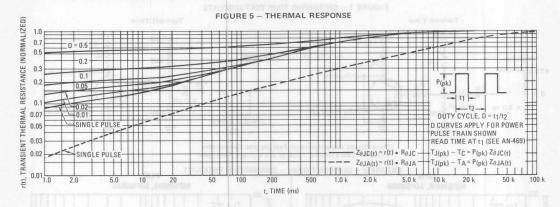


FIGURE 6 — ACTIVE REGION, SAFE OPERATING AREA MPS8098, MPS8099

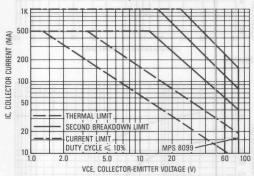
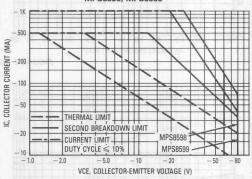
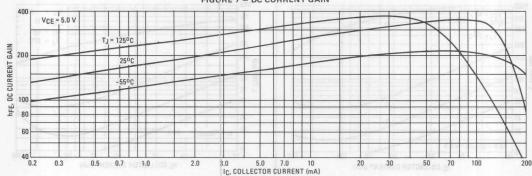


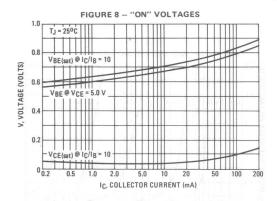
FIGURE 6 — ACTIVE REGION, SAFE OPERATING AREA MPS8598, MPS8599

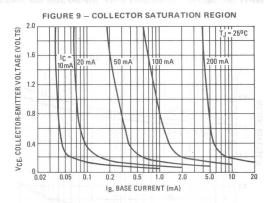


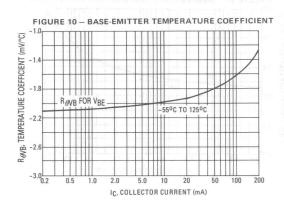
MPS8098, MPS8099

FIGURE 7 - DC CURRENT GAIN

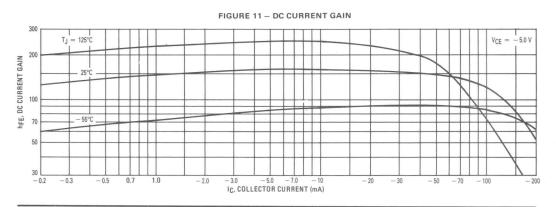


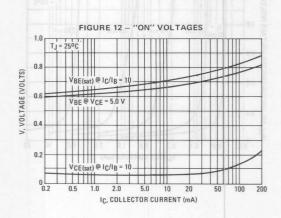


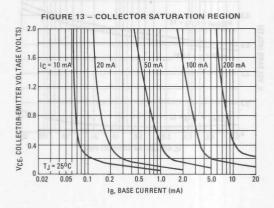


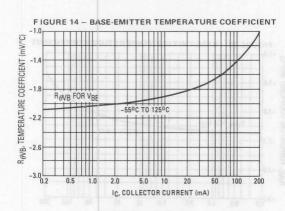


MPS8598, MPS8599









Rating	Symbol	MPSA05 MPSA55	MPSA06 MPSA56	Unit
Collector-Emitter Voltage	VCEO	60	80	Vdc
Collector-Base Voltage	V _{CBO}	60	80	Vdc
Emitter-Base Voltage	V _{EBO}	4	.0	Vdc
Collector Current — Continuous	Ic	500		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1	625 5.0	
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	200	°C/W
Thermal Resistance, Junction to Case	R_{θ} JC	83.3	°C/W

(1) $R_{ heta JA}$ is measured with the device soldered into a typical printed circuit board.

NPN MPSA05 MPSA06*



PNP⁽³⁾ MPSA55



CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

★These are Motorola designated preferred devices.

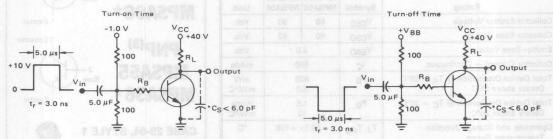
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS				The state of	17 7
Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0)	MPSA05, MPSA55 MPSA06, MPSA56	V(BR)CEO	60 80	=	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)		V _{(BR)EBO}	4.0	-	Vdc
Collector Cutoff Current (V _{CE} = 60 Vdc, I _B = 0)		ICES	-	0.1	μAdc
Collector Cutoff Current ($V_{CB} = 60 \text{ Vdc}$, $I_{E} = 0$) ($V_{CB} = 80 \text{ Vdc}$, $I_{E} = 0$)	MPSA05, MPSA55 MPSA06, MPSA56	ІСВО		0.1 0.1	μAdc
ON CHARACTERISTICS	CY = V - V - KAC 6	de or	- P.	LT NO D	18 05
DC Current Gain (I _C = 10 mAdc, V_{CE} = 1.0 Vdc) (I _C = 100 mAdc, V_{CE} = 1.0 Vdc)		hFE	100 100	_	_
Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 10 mAdc)		VCE(sat)	_	0.25	Vdc
Base-Emitter On Voltage (I _C = 100 mAdc, V _{CE} = 1.0 Vdc)	DAMATE CLARK - 1, 200 TAB	V _{BE(on)}	_	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS			PHO VI		•
Current-Gain — Bandwidth Product(2) (IC = 10 mA, V _{CE} = 2.0 V, f = 100 MHz)	MPSA05 MPSA06	fT	100		MHz
$(I_{C} = 100 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}, f = 100 \text{ MHz})$	MPSA55 MPSA56		50	-	- 01

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

(2) fT is defined as the frequency at which |hfe| extrapolates to unity.

(3) Voltage and Current are negative for PNP Transistors.



*Total Shunt Capacitance of Test Jig and Connectors
For PNP Test Circuits, Reverse All Voltage Polarities

FIGURE 2 — CURRENT-GAIN — BANDWIDTH PRODUCT

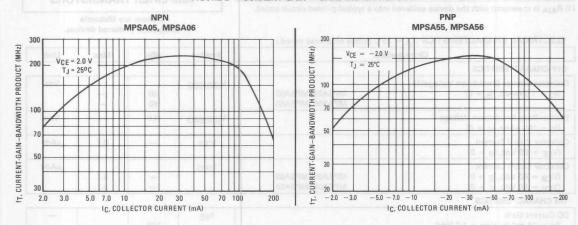
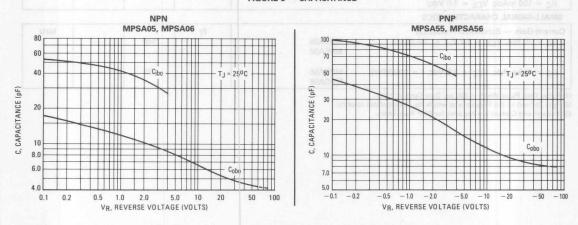
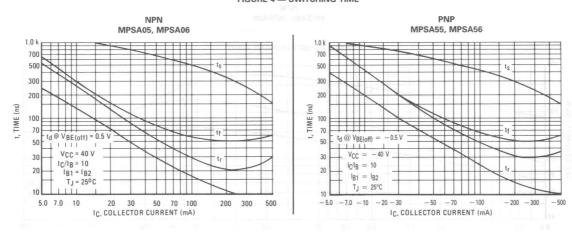


FIGURE 3 — CAPACITANCE



NPN MPSA05 MPSA06 PNP MPSA55 MPSA56

FIGURE 4 — SWITCHING TIME



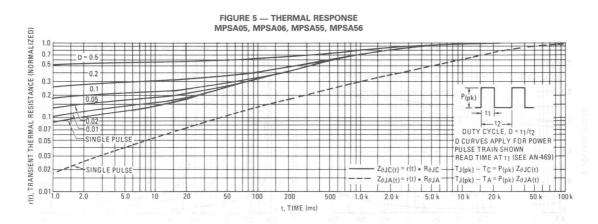
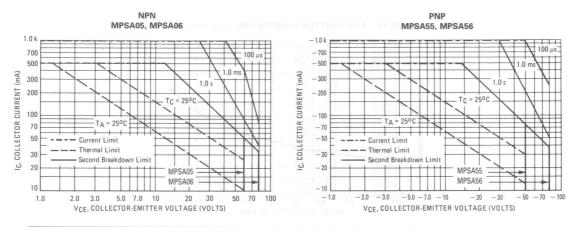
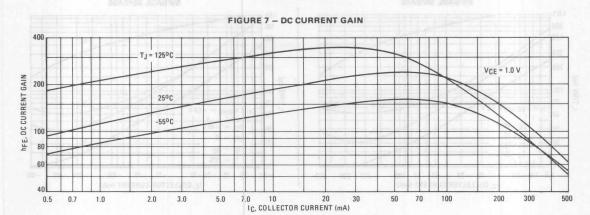


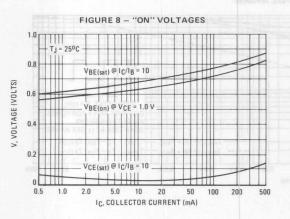
FIGURE 6 — ACTIVE — REGION SAFE OPERATING AREA

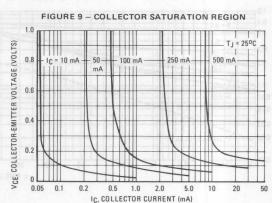


NPN MPSA05 MPSA06 PNP MPSA55 MPSA56

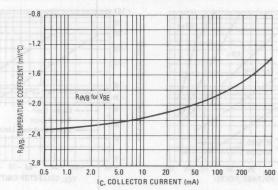
NPN MPSA05, MPSA06











NPN MPSA05 MPSA06 PNP MPSA55 MPSA56

PNP MPSA55, MPSA56

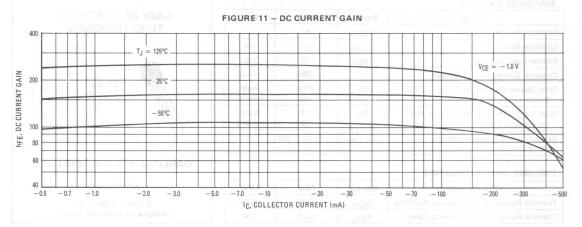
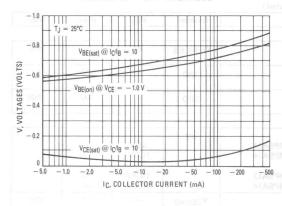


FIGURE 12 - "ON" VOLTAGES

FIGURE 13 - COLLECTOR SATURATION REGION



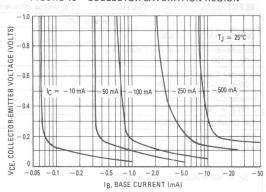
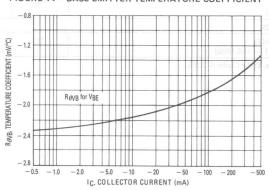


FIGURE 14 - BASE-EMITTER TEMPERATURE COEFFICIENT



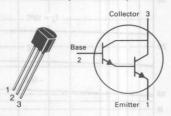
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCES	30	Vdc
Collector-Base Voltage	VCBO	30	Vdc
Emitter-Base Voltage	VEBO	10	Vdc
Collector Current — Continuous	Ic	500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	- 55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	R_{θ} JC	83.3	°C/W

MPSA13 MPSA14*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

Refer to 2N6426 for graphs.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, I _B = 0)	160-3	V _(BR) CES	30	1 (0) tady (8)	Vdc
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0)	150-8	ІСВО		100	nAdc
Emitter Cutoff Current (VEB = 10 Vdc, I _C = 0)	N 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	I _{EBO}		100	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I _C = 10 mAdc, V _{CE} = 5.0 Vdc)	MPSA13 MPSA14	hFE	5000 10,000	19) (sa) 17	
(I _C = 100 mAdc, V _{CE} = 5.0 Vdc)	MPSA13 MPSA14	- IB - IB - IB (Am) TIGRA	10,000 20,000	03 - 63 cal -	03-
Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 0.1 mAdc)		VCE(sat)	-	1.5	Vdc
Base-Emitter On Voltage (I _C = 100 mAdc, V _{CE} = 5.0 Vdc)	JEMITTER TEMPERATI	V _{BE}	-	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					HIP
Current-Gain — Bandwidth Product(2) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz)		fT	125	-	MHz

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ $f_T = |h_{fe}| \cdot f_{test}$.

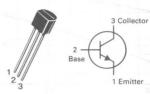
MAXIMON NATINGS			TO A STATE OF THE PARTY OF THE	
Rating	Symbol	MPS-A16	MPS-A17	Unit
Collector-Emitter Voltage	VCEO	4	0	Vdc
Emitter-Base Voltage	VEBO	12	15	Vdc
Collector Current — Continuous	IC	100		mAdc
Total Device Dissipation @ $T_A = 25^{\circ}C$ Derate above $25^{\circ}C$	PD	350 2.8		mW mW/°C
Total Device Dissipation @ $T_C = 25^{\circ}C$ Derate above $25^{\circ}C$	PD	1.0 8.0		Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to	+150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

MPSA16 MPSA17*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



CHOPPER TRANSISTORS

NPN SILICON

★This is a Motorola designated preferred device.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS		Jan 1991			30
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)		V(BR)CE	0 40	-	Vdc
Emitter-Base Breakdown Voltage $(I_E = 0.1 \text{ mAdc}, I_C = 0)$	MPS-A16 MPS-A17	V(BR)EBO	12 15	=	Vdc
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0)		ICBO		100	nAdc
Emitter Cutoff Current (VEB = 10 Vdc, I _C = 0)		IEBO	1 + 1 /	100	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$)	(i	hFE	200	600	+0
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)		V _{CE(sat)}	_	0.25	Vdc
SMALL-SIGNAL CHARACTERISTICS		•			
Current-Gain — Bandwidth Product $(I_C = 5.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 100 \text{ MHz})$	MPS-A16 MPS-A17	fT	100 80	_	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	Ť	Cobo	441-110 -1	4.0	pF

FIGURE 1 - DC CURRENT GAIN

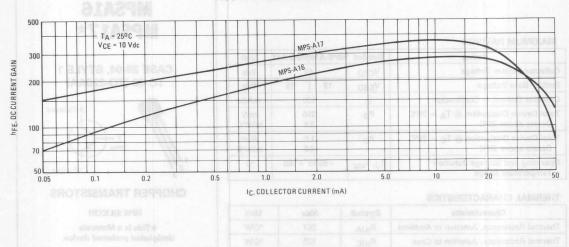


FIGURE 2 - SMALL SIGNAL CURRENT GAIN

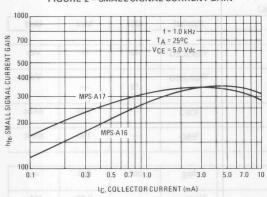


FIGURE 3 - SATURATION AND ON VOLTAGES

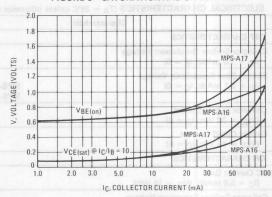


FIGURE 4 - CURRENT-GAIN-BANDWIDTH PRODUCT

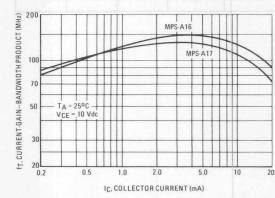
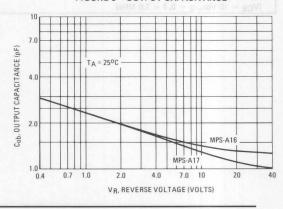


FIGURE 5 - OUTPUT CAPACITANCE



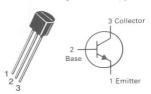
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	45	Vdc
Collector-Base Voltage	V _{CBO}	45	Vdc
Emitter-Base Voltage	V _{EBO}	6.5	Vdc
Collector Current — Continuous	1 _C	200	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	200	°C/W
Thermal Resistance, Junction to Case	Reic	83.3	°C/W

MPSA18*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



LOW NOISE TRANSISTOR

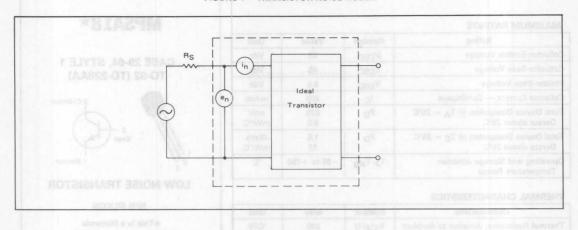
NPN SILICON

★This is a Motorola designated preferred device.

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	YDu R	20/15/31/10	STORTE	шигу	4
Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0)	V(BR)CEO	45		_	Vdc
Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0)	V _(BR) CBO	45	-	_	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V(BR)EBO	6.5	_	_	Vdc
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0)	ICBO		1.0	50	nAdc
ON CHARACTERISTICS(2)				11-1	30-18.1
DC Current Gain	hFE	400 500 500 500	580 850 1100 1150	 1500	01
Collector-Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}$, $I_B = 0.5 \text{ mAdc}$) ($I_C = 50 \text{ mAdc}$, $I_B = 5.0 \text{ mAdc}$)	VCE(sat)	_	 0.08	0.2 0.3	Vdc
Base-Emitter On Voltage (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc)	V _{BE(on)}	_	0.6	0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS			,		
Current-Gain — Bandwidth Product (IC = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz)	fT	100	160	_	MHz
Collector-Base Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	C _{cb}	_	1.7	3.0	pF
Emitter-Base Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	C _{eb}	-	5.6	6.5	pF
Noise Figure (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k Ω , f = 1.0 kHz) (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 1.0 k Ω , f = 100 Hz)	NF	= 1	0.5 4.0	1.5	dB
Equivalent Short Circuit Noise Voltage (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 1.0 k Ω , f = 100 Hz)	VT		6.5		nV/√Hz

⁽¹⁾ R_{θ , JA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width \leqslant 300 μ s, Duty Cycle \leqslant 2.0%.

FIGURE 1 - TRANSISTOR NOISE MODEL



NOISE CHARACTERISTICS

(VCE = 5.0 Vdc, TA = 25°C)

NOISE VOLTAGE

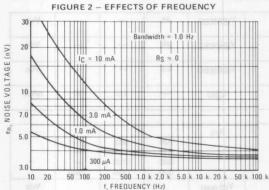
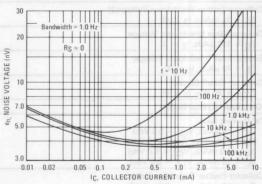
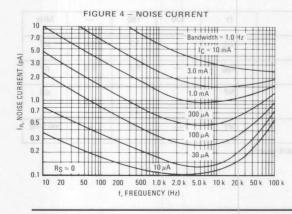
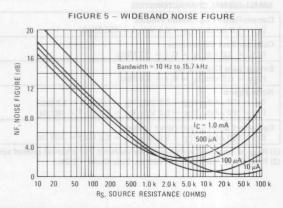


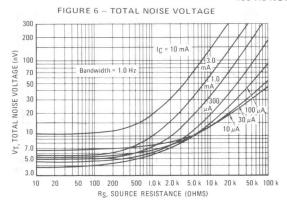
FIGURE 3 – EFFECTS OF COLLECTOR CURRENT







100 Hz NOISE DATA



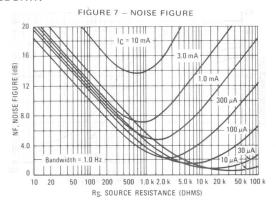


FIGURE 8 — DC CURRENT GAIN

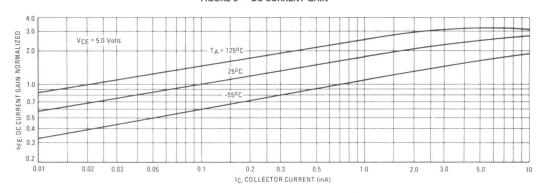


FIGURE 9 - "ON" VOLTAGES

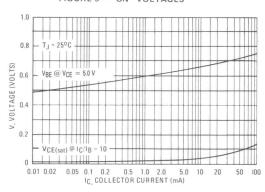


FIGURE 10 - TEMPERATURE COEFFICIENTS

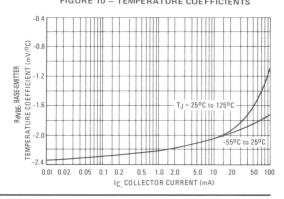


FIGURE 11 - CAPACITANCE

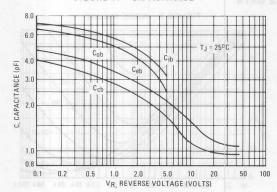
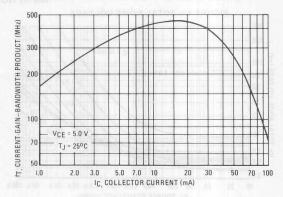


FIGURE 12 - CURRENT-GAIN-BANDWIDTH PRODUCT



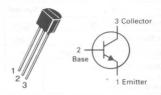
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	VCBO	4.0	Vdc
Collector Current — Continuous	IC	100	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W

MPSA20

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPS3904 for graphs.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	·				\$ 12,040,49
Collector-Emitter Breakdown Voltage(2) (I _C = 1.0 mAdc, I _B = 0)	X180) CES	V(BR)CEO	40	10,575 <u>-</u>	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μ Adc, I _C = 0)	DODINA	V(BR)EBO	4.0	ost <u>i</u> sh Ulania	Vdc
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0)	0.30	ICBO	_	100	nAdc
ON CHARACTERISTICS				10 4	Man anvi
DC Current Gain(2) (I _C = 5.0 mAdc, V _{CE} = 10 Vdc)	135	hFE	40	400	li ir fot like
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)		VCE(sat)	-	0.25	Vdc
SMALL-SIGNAL CHARACTERISTICS	0.52			tru i u	chul letting
Current-Gain — Bandwidth Product(2) (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz		f _T	125	1.5.	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	9.70	C _{obo}	_	4.0	pF

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

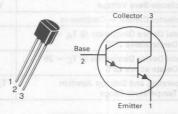
Rating	Symbol	MPS-A25	MPS-A26	MPS-A27	Unit
Collector-Emitter Voltage	VCES	40	50	60	Vdc
Emitter-Base Voltage	VEBO		10		Vdc
Collector Current — Continuous	Ic		500	0	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD		625 5.0	087 ± 1	mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-	55 to +1	50	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

MPSA27

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



DARLINGTON TRANSISTOR

NPN SILICON

Character	istic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					gor staaro	AUDIES S
Collector-Emitter Breakdown Voltage ($I_C = 100 \mu Adc, V_{BE} = 0$)	V(8R)CED	V(BR)CES	60	Slegstov awa	biles (3 toli)	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	083(88) ^V	V(BR)CBO	60	ags/loV	mwoosleen8	Vdc
Collector Cutoff Current $(V_{CB} = 30 \text{ V}, I_{E} = 0)$ $(V_{CB} = 40 \text{ V}, I_{E} = 0)$ $(V_{CB} = 50 \text{ V}, I_{E} = 0)$		ІСВО		-	100 3 = 31 abV	nAdc ao
Collector Cutoff Current (VCE = 30 V, VBE = 0) (VCE = 40 V, VBE = 0) (VCE = 50 V, VBE = 0)	Note last	ICES	-		500	n3-tottel
Emitter Cutoff Current (VEB = 10 Vdc)		I _{EBO}	-	SOCIEDATION IN THE PROPERTY OF	100	nAdc
ON CHARACTERISTICS(1)			\$11M 001	= 10 Vdc. f =	= anV_abAn	108 = 2
DC Current Gain (I _C = 10 mA, V _{CE} = 5.0 V) (I _C = 100 mA, V _{CE} = 5.0 V)	odo ⁰	hFE	10,000	HM C+ = 1	citance Vdo , it = 0	p or Capa Vcg = 1
Collector-Emitter Saturation Voltage (I _C = 100 mA, I _B = 0.1 mAdc)		VCE(sat)	S ≥ e(5, C) yn.	0 ,au, 0 26 ≥ 1	1.5	Vdc
Base-Emitter On Voltage (I _C = 100 mA, V _{CE} = 5.0 Vdc)		VBE(on)		=	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Small Signal Current Gain (IC = 10 mA, VCE = 5.0 V, f = 100 M	ЛHz)	h _{fe}	1.25	2.4	-	-
) Pulse Test: Pulse Width ≤ 300 us. Duty Cvo	ele ≤ 2.0%.					

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 - DC CURRENT GAIN

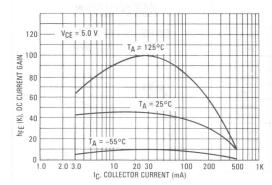


FIGURE 2 - "ON" VOLTAGES

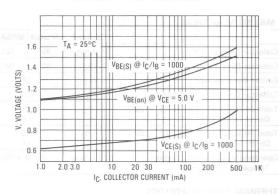


FIGURE 3 — COLLECTOR SATURATION REGION

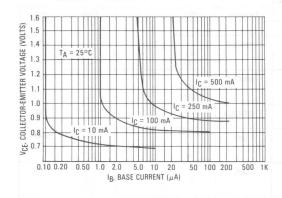


FIGURE 4 — HIGH FREQUENCY CURRENT GAIN

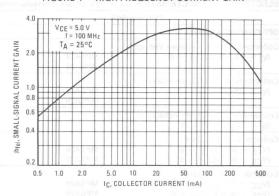
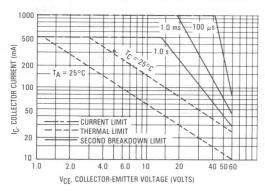


FIGURE 5 — ACTIVE REGION SAFE OPERATING AREA



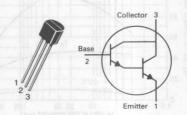
Rating	Symbol	MPSA28	MPSA29	Unit
Collector-Emitter Voltage	VCES	80	100	Vdc
Collector-Base Voltage	VCBO	80	100	Vdc
Emitter-Base Voltage	VEBO	12		Vdc
Collector Current — Continuous	Ic	500		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

THE THINK OF THE THOU			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	Reic	83.3	°C/W

MPSA28 MPSA29*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

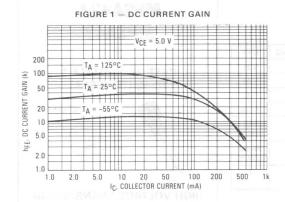
NPN SILICON

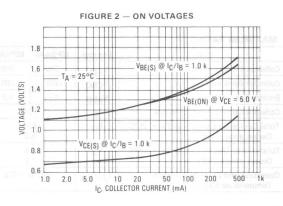
★This is a Motorola designated preferred device.

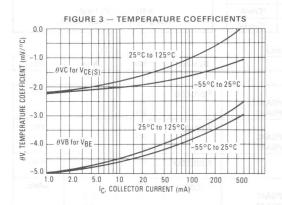
Characteris	stic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	VOX - BOV 10					
Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, V _{BE} = 0)	MPSA28 MPSA29	V(BR)CES	80 100	=	-	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	MPSA28 MPSA29	V(BR)CBO	80 100			Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	V(BR)EBO	12	111 H	41	Vdc
Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 80 Vdc, I _E = 0)	MPSA28 MPSA29	СВО			100 100	nAdo
Collector Cutoff Current (VCE = 60 Vdc, VBE = 0) (VCE = 80 Vdc, VBE = 0)	MPSA28 MPSA29	ICES	20 50 108 (µA)	AT 0.8 G. GASE <u>GU</u> RRENT —	500 500	nAdd
Emitter Cutoff Current (VEB = 10 Vdc, I _C = 0)		IEBO	-	-	100	nAdd
ON CHARACTERISTICS(1)						
DC Current Gain (I _C = 10 mAdc, V_{CE} = 5.0 Vdc) (I _C = 100 mAdc, V_{CE} = 5.0 Vdc)	ION SAFE OPERATING AREA	en avec	10,000 10,000	=		-
Collector-Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}$, $I_B = 0.01 \text{ mAdc}$) ($I_C = 100 \text{ mAdc}$, $I_B = 0.1 \text{ mAdc}$)	/su, 201 /su, 0.1	VCE(sat)	500 Z	0.7 0.8	1.2 1.5	Vdc
Base-Emitter On Voltage (I _C = 100 mAdc, V _{CE} = 5.0 Vdc)	HALLES	V _{BE(on)}	- G03	1.4	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS	HIME VIDE	141		8		
Current-Gain — Bandwidth Product(2) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 1	00 MHz)	fT	125	200	7	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}		5.0	8.0	pF

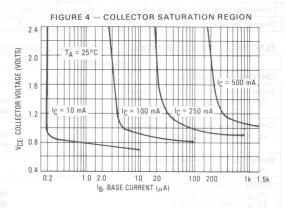
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (2) f_T = h_{fe} * f_{test}.

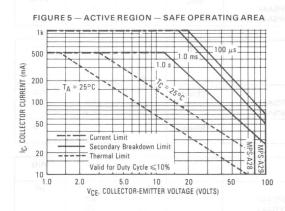
MPSA28 MPSA29

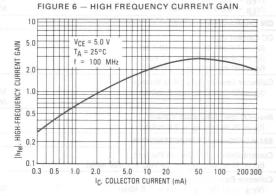












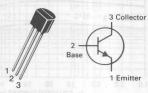
Rating	Symbol	MPSA42	MPSA43	Unit
Collector-Emitter Voltage	VCEO	300	200	Vdc
Collector-Base Voltage	VCBO	300	200	Vdc
Emitter-Base Voltage	VEBO	6.0	6.0	Vdc
Collector Current — Continuous	Ic	500		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

			and the same of th
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/mW
Thermal Resistance, Junction to Case	Reic	83.3	°C/mW

MPSA42* MPSA43

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

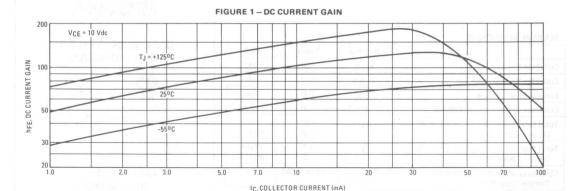
NPN SILICON

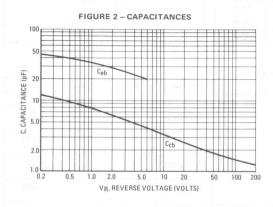
★This is a Motoroladesignated preferred device.

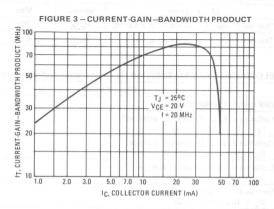
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0)	MPSA42 MPSA43	V(BR)CEO	300 200		Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	MPSA42 MPSA43	V(BR)CBO	300 200	18V not	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μ Adc, I _C = 0)		V(BR)EBO	6.0		Vdc
Collector Cutoff Current $(V_{CB} = 200 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = 160 \text{ Vdc}, I_{E} = 0)$	MPSA42 MPSA43	ІСВО	DRRUG ROTALI	0.1 0.1	μAdc
Emitter Cutoff Current (VEB = 6.0 Vdc, I _C = 0) (VEB = 4.0 Vdc, I _C = 0)	MPSA42 MPSA43	I _{EBO}	- H <u>O</u> (03)	0.1 0.1	μAdc
ON CHARACTERISTICS(1)		TELESCOT			
DC Current Gain (I _C = 1.0 mAdc, V_{CE} = 10 Vdc) (I _C = 10 mAdc, V_{CE} = 10 Vdc) (I _C = 30 mAdc, V_{CE} = 10 Vdc)	0.5 au 11.0 au	hFE and the	25 40 40		300
Collector-Emitter Saturation Voltage (IC = 20 mAdc, IB = 2.0 mAdc)	MPSA42 MPSA43	VCE(sat)		0.5 0.4	Vdc
Base-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc)		V _{BE(sat)}		0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS	二 66 年 開発4		Bryandown Lim	risbnood	20 -
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)		fT	50	joi bluv	MHz
Collector-Base Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 1.0 MHz)	MPSA42 MPSA43	C _{cb}	ASTTIMA-ROTO:	3.0 4.0	pF

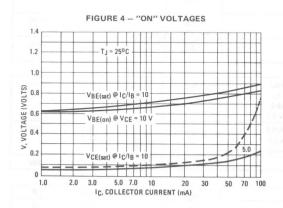
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

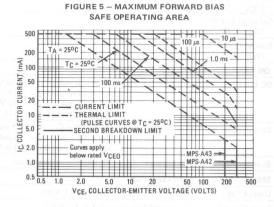
MPSA42 MPSA43











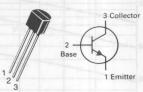
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	400	Vdc
Collector-Base Voltage	VCBO	500	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	Ic	300	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W

MPSA44*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Char	acteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS					TIME E
Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0)		V _(BR) CEO	400		Vdc
Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, V _{BE} = 0)		V _(BR) CES	500		Vdc
Collector-Base Breakdown Voltage (I _C = 100, μ Adc, I _E = 0)		V(BR)CBO	500		Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	13.01	V _{(BR)EBO}	6.0	w . -	Vdc
Collector Cutoff Current (VCB = 400 Vdc, I _E = 0)	1 - 8 38UDP	ICBO		0.1	μAdc
Collector Cutoff Current (VCE = 400 Vdc, VBE = 0)	DESCRIPTION OF THE PROPERTY OF	ICES	/**(8(<u>3*</u> -)	500	nAdc
Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0)	200 AT 100	I _{EBO}		0.1	μAdc
ON CHARACTERISTICS(1)					0.1
DC Current Gain(1)	(I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 50 mAdc, V _{CE} = 10 Vdc) (I _C = 100 mAdc, V _{CE} = 10 Vdc)	hFE	40 50 45 40	200 —	8.0 %
Collector-Emitter Saturation Voltage(1) (I _C = 1.0 mAdc, I _B = 0.1 mAdc) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc)		VCE(sat)		0.4 0.5 0.75	Vdc
Base-Emitter Saturation Voltage (IC =	10 mAdc, I _B = 1.0 mAdc)	V _{BE(sat)}		0.75	Vdc
SMALL-SIGNAL CHARACTERISTICS			or 63 03	20.00	0.1
Output Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}	RAUS <u>EG</u> T 79.1.	7.0	pF
Input Capacitance (VEB = 0.5 Vdc, IC	= 0, f = 1.0 MHz)	C _{ibo}		130	pF
Small-Signal Current Gain $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 2)$	0 MHz)	h _{fe}	1.0	-	-
N Bules Tests Bules Width = 200 - Date Con	1 0.00/				

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 - DC CURRENT GAIN

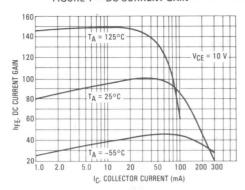


FIGURE 2 — COLLECTOR SATURATION REGION

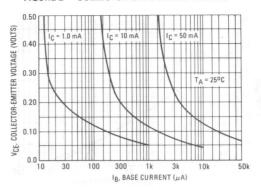


FIGURE 3 — ON VOLTAGES

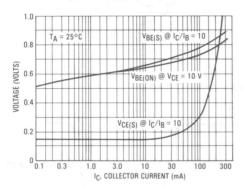


FIGURE 4 — ACTIVE REGION — SAFE OPERATING AREA

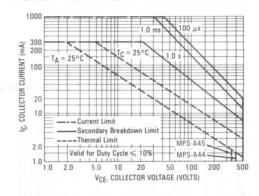


FIGURE 5 - CAPACITANCE

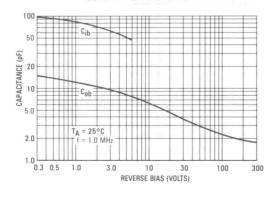
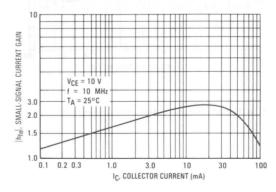
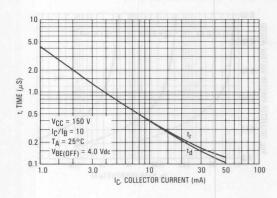


FIGURE 6 - HIGH FREQUENCY CURRENT GAIN



MODER MODERNITA FIGURE 7 — TURN-ON SWITCHING TIMES AND TEST CIRCUIT MEDICAL AND SWITCHING TIMES AND SWITCHING TIMES AND TEST CIRCUIT MEDICAL AND SWITCHING TIMES AND S



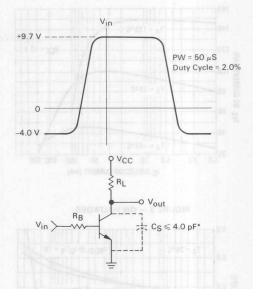
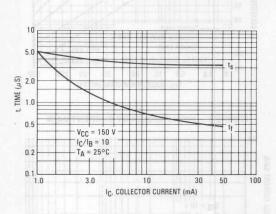
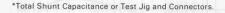
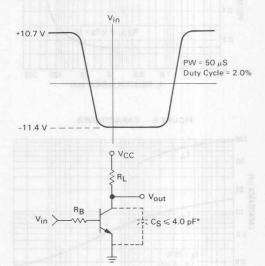


FIGURE 8 — TURN-OFF SWITCHING TIMES AND TEST CIRCUIT







MPSA55, MPSA56 For Specifications,

See MPSA05, MPSA06 Data

MAXIMUM RATINGS

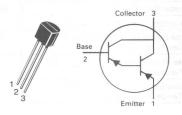
Rating	Symbol	MPSA62	MPSA63 MPSA64	Unit
Collector-Emitter Voltage	VCES	-20	-30	Vdc
Collector-Base Voltage	V _{CBO}	-20	-30	Vdc
Emitter-Base Voltage	V _{EBO}	994	10	Vdc
Collector Current — Continuous	IC	-500		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0		mW mW/°C
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	– 55 to	o +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W

MPSA62 thru MPSA64*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

PNP SILICON **★MPSA64** is a Motorola designated preferred device.

Refer to MPSA75 for graphs.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS				a" - 81934	DARWING WA
Collector-Emitter Breakdown Voltage (IC = $-100 \mu Adc$, $V_{BE} = 0$)	MPSA62 MPSA63, MPSA64	V(BR)CES	-20 -30	_	Vdc
Collector Cutoff Current (V _{CB} = -15 Vdc, I _E = 0) (V _{CB} = -30 Vdc, I _E = 0)	MPSA62 MPSA63, MPSA64	ICBO	_	- 100 - 100	nAdc
Emitter Cutoff Current (VEB = -10 Vdc, I _C = 0)		IEBO	_	-100	nAdc
ON CHARACTERISTICS(1)			- (0.Vo) = =		W. = 50
DC Current Gain ($I_C = -10 \text{ mAdc}$, $V_{CE} = -5.0 \text{ Vdc}$)	MPSA63 MPSA64 MPSA62	hFE	5000 10,000 20,000	=	oreominion or of or electrons
$(I_C = -100 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc})$	MPSA63 MPSA64	HILIXO	10,000 20,000	=	
Collector-Emitter Saturation Voltage ($I_C = -10$ mAdc, $I_B = -0.01$ mAdc) ($I_C = -100$ mAdc, $I_B = -0.1$ mAdc)	MPSA62 MPSA63, MPSA64	VCE(sat)	1(* () -) .	- 1.0 - 1.5	Vdc
Base-Emitter On Voltage $ \begin{aligned} &(I_C = -10 \text{ mAdc, V}_{CE} = -5.0 \text{ Vdc}) \\ &(I_C = -100 \text{ mAdc, V}_{CE} = -5.0 \text{ Vdc}) \end{aligned} $	MPSA62 MPSA63, MPSA64	V _{BE(on)}	=	- 1.4 - 2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) ($I_C = -100 \text{ mAdc}$, $V_{CE} = -5.0 \text{ Vdc}$, $f = 100 \text{ MHz}$)	MPSA63, MPSA64	fT	125	_	MHz

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

⁽²⁾ $f_T = |h_{fe}| \cdot f_{test}$.

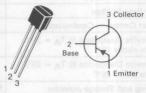
III DAIIII III II		\$1731.33 E173545 7113	
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-40	Vdc
Emitter-Base Voltage	VEBO	-4.0	Vdc
Collector Current — Continuous	Ic	-100	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

THE MINE OF A THOUGH			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	R _B JC	83.3	°C/W

MPSA70

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

PNP SILICON

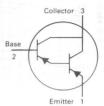
Refer to 2N5086 for graphs.

Charac	teristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					200721537	DANAMO :
Collector-Emitter Breakdown Voltage (I _C = -1.0 mAdc, I _B = 0)	Viances	MPSAIZ	V _{(BR)CEO}	-40	dar B ro akdow u Ade, Vue	Vdc
Emitter-Base Breakdown Voltage (I _E = -100 µAdc, I _C = 0)	pinal	MPSAGE, MPSAGE	V(BR)EBO	-4.0	Inertic th	Vdc
Collector Cutoff Current (VCB = -30 Vdc, IE = 0)		MPSARS MPSAGS, MPSAGS	ICBO	- 1	-100	nAdc
ON CHARACTERISTICS	OBFI				Cerrent	HoruQ remi
DC Current Gain (IC = -5.0 mAdc, VCE = -10 Vdc)			hFE	40	400	CHARACT
Collector-Emitter Saturation Voltage (I _C = -10 mAdc, I _B = -1.0 mAdc)	39/1	MPRAES	VCE(sat)	(obV 0.6-	-0.25	Vdc
SMALL-SIGNAL CHARACTERISTICS		PROAG INA CALUDAX				
Current-Gain — Bandwidth Product (I _C = -5.0 mAdc, V _{CE} = -10 Vdc, f =	= 100 MHz)	MPSARS	f _T	125	agV.sbAm	MHz
Output Capacitance (VCB = -10 Vdc, IF = 0, f = 1.0 MHz)	Verseum	PARTIN PARTIE	C _{obo}	ebstick r	4.0	pf

MPSA75 MPSA77

CASE 29-04, STYLE 1 TO-92 (TO-226AA)





DARLINGTON TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MPSA75	MPSA77	Unit
Collector-Emitter Voltage	VCES	-40	-60	Vdc
Emitter-Base Voltage	VEBO		10	Vdc
Collector Current — Continuous	IC	-500		Adc
Total Device Dissipation @ $T_A = 25^{\circ}C$ Derate above 25°C	PD	625 5.0		mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	- 55 to	+ 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS		Te No. 11 ft	16			
Collector-Emitter Breakdown Voltage (IC = $-100 \mu Adc$, VBE = 0)	MPSA75 MPSA77	V(BR)CES	-40 -60		_	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	MPSA75 MPSA77	V(BR)CBO	-40 -60	=	=	Vdc
Collector Cutoff Current (V _{CB} = -30 V, I _E = 0) (V _{CB} = -50 V, I _E = 0)	MPSA75 MPSA77	ІСВО	<u>-</u>	10.11 <u>10.</u> p	- 100 - 100	nAdc
Collector Cutoff Current $(V_{CE} = -30 \text{ V, V}_{BE} = 0)$ $(V_{CE} = -50 \text{ V, V}_{BE} = 0)$	MPSA75 MPSA77	ICES	199 YNG	023293346	-500 -500	nAdc
Emitter Cutoff Current (V _{EB} = -10 Vdc)		IEBO	-	- I	-100	nAdc
ON CHARACTERISTICS				-		1
DC Current Gain (I _C = -10 mA, V _{CE} = -5.0 V) (I _C = -100 mA, V _{CE} = -5.0 V)	m	hFE	10,000 10,000	_		
Collector-Emitter Saturation Voltage ($I_C = -100 \text{ mA}$, $I_B = -0.1 \text{ mAdc}$)		V _{CE(sat)}	-	-	-1.5	Vdc
Base-Emitter On Voltage ($I_C = -100 \text{ mA}$, $V_{CE} = -5.0 \text{ Vdc}$)	2	VBE	_		-2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — High Frequency $(I_C = -10 \text{ mA}, V_{CE} = -5.0 \text{ V}, f = 100 \text{ MHz})$	11	h _{fe}	1.25	2.4		_

FIGURE 1 - DC CURRENT GAIN

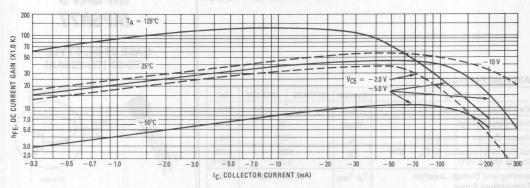


FIGURE 2 - "ON" VOLTAGE

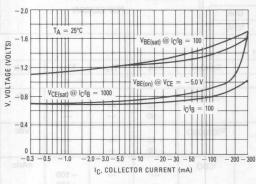


FIGURE 3 — COLLECTOR SATURATION REGION

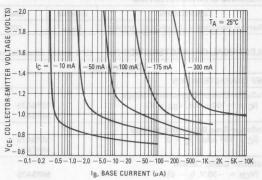


FIGURE 4 — HIGH FREQUENCY CURRENT GAIN

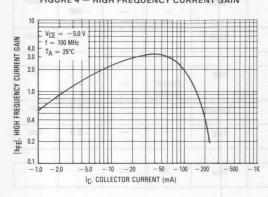
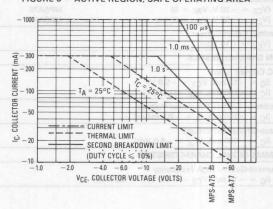


FIGURE 5 — ACTIVE REGION, SAFE OPERATING AREA



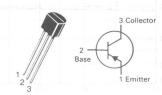
Rating	Symbol	MPSA92	MPSA93	Unit
Collector-Emitter Voltage	VCEO	-300	-200	Vdc
Collector-Base Voltage	VCBO	-300	-200	Vdc
Emitter-Base Voltage	VEBO	_	5.0	Vdc
Collector Current — Continuous	Ic	-!	500	mAdc
Total Device Dissipation @ TA = 25°c Derate above 25°C	PD	-	25 .0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD		.5 2	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to	+150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	R ₀ .IC	83.3	°C/W

MPSA92* MPSA93

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



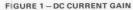
HIGH VOLTAGE TRANSISTORS

PNP SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteris	tic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) $(I_C = -1.0 \text{ mAdc}, I_B = 0)$	MPSA92 MPSA93		V(BR)CEO	-300 -200		Vdc
Collector-Base Breakdown Voltage (I _C = $-100 \mu Adc$, I _E = 0)	MPSA92 MPSA93	11 1 10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	V(BR)CBO	-300 -200		Vdc
Emitter-Base Breakdown Voltage (IE = $-100 \mu Adc$, IC = 0)			V(BR)EBO	-5.0	SIV -	Vdc
Collector Cutoff Current ($V_{CB} = -200 \text{ Vdc}$, $I_{E} = 0$) ($V_{CB} = -160 \text{ Vdc}$, $I_{E} = 0$)	MPSA92 MPSA93		ICBO	CV WO'-	-0.25 -0.25	μAdc
Emitter Cutoff Current (V _{EB} = -3.0 Vdc, I _C = 0)			I _{EBO}		-0.1	μAdc
ON CHARACTERISTICS(1)		The second				1411
DC Current Gain $ \begin{aligned} &(I_C = -1.0 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}) \\ &(I_C = -10 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}) \end{aligned} $ $ \begin{aligned} &(I_C = -30 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}) \end{aligned} $	Both Types Both Types MPSA92		hFE	25 40 25		51
	MPSA93			25	_	
Collector-Emitter Saturation Voltage ($I_C = -20 \text{ mAdc}$, $I_B = -2.0 \text{ mAdc}$)	MPSA92 MPSA93		VCE(sat)	Jul - 10-12	-0.5 -0.4	Vdc
Base-Emitter Saturation Voltage $(I_C = -20 \text{ mAdc}, I_B = -2.0 \text{ mAdc})$	- 0 d 0 0		V _{BE(sat)}	01	-0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS	A12		JAM FKSA	(1,1)8 V 112		
Current-Gain — Bandwidth Product ($I_C = -10 \text{ mAdc}, V_{CE} = -20 \text{ Vdc}, f = 100$	MHz)		fT	50	_	MHz
Collector-Base Capacitance (V _{CB} = -20 Vdc, I _E = 0, f = 1.0 MHz)	MPSA92 MPSA93		C _{cb}	_	6.0 8.0	pF



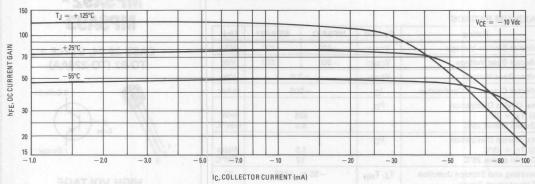


FIGURE 2 - CAPACITANCES

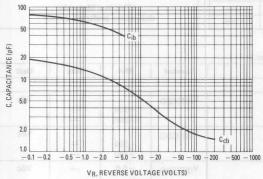
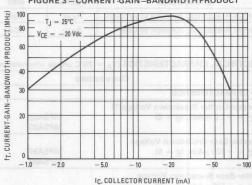


FIGURE 3 - CURRENT-GAIN-BANDWIDTH PRODUCT



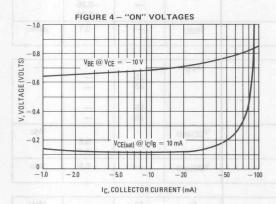
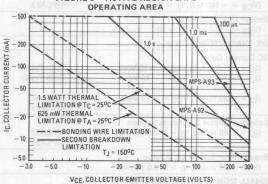


FIGURE 5 - ACTIVE-REGION SAFE



Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	80	Vdc
Emitter-Base Voltage	VEBO	4.0	Vdc
Collector Current — Continuous	IC	in 100	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	LNTZ ₀C

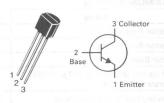
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	83.3	°C/W

(1) $R_{ heta JA}$ is measured with the device soldered into a typical printed circuit board.

MPSH04

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS				en arano	FF CHARL
Collector-Emitter Breakdown Voltage(2) (IC = 1.0 mAdc, IB = 0)	V(BR)CEO	80	cetteV <u>reect</u> (i)	8 . 104 °	Vdc
Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0)	V(BR)CBO	80	apat <u>io</u> l' ry		Vdc
Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0)	V(BR)EBO	4.0	ag <u>sat</u> ok -	- <u>-</u> 3	Vdc
Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0)	ІСВО	_	- (0	50	nAdc
Emitter Cutoff Current (V _{EB} = 3.0 Vdc, I _C = 0)	IEBO	_		50	nAdc
ON CHARACTERISTICS			(sbv. 04 =	1 . 6	10 = 2 1
DC Current Gain (I _C = 1.5 mAdc, V _{CE} = 10 Vdc)	hFE	30	(dev <u>il</u>)	120	ac Emitter (to = 3.0) MALL-SE
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	VCE(sat)	Elvi acr =	hubo tt rib 1 odust =	0.25	Vdc
SMALL-SIGNAL CHARACTERISTICS			9000	, a	n E-romali
Crrent-Gain — Bandwidth Product (I _C = 1.5 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	t _{Louise}	80	W 0.4 = \ D	-	MHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, f = 1.0 MHz)	Ccb	0.03= S	= " <u>0.</u> V0c, 8	1.6	pF
Output Admittance (I _C = 1.5 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	h _{oe}	This	D tawot nuc RubV UI =	5.0	μmhos
Noise Figure (I _C = 1.5 mAdc, V_{CE} = 10 Vdc, R_S = 50 ohms, f = 1.0 MHz) MPS	SH04	G 48— 2	9 aby <u>A</u> r	2.0	dB

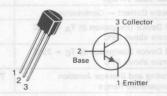
MAXIMOM HATHIGO			
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	30	Vdc
Collector-Base Voltage	VCBO	30	Vdc
Emitter-Base Voltage	VEBO	3.0	Vdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	R _B JC	125	°C/W

MPSH07A

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



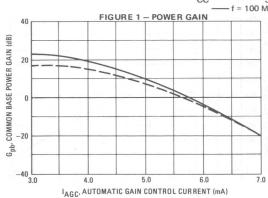
FM/VHF TRANSISTOR

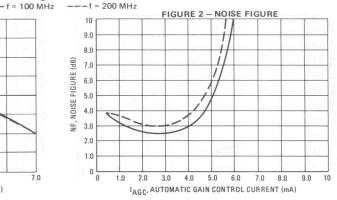
NPN SILICON

Characteristic Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS			201 PH31	P CHARAC
Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0)	V _{(BR)CEO}	30	ter B ro skdeyn Ado, Ig = 0)	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	V _(BR) CBO	30	Sina k down V Adc. Ip = 0)	Vdc
Emitter-Base Breakdown Voltage (IE = 100 μ Adc, IC = 0)	V _{(BR)EBO}	3.0	iroak do wn Vo Ndc. Id = 0)	Vdc
Collector Cutoff Current (VCB = 15 Vdc, IE = 0)	ІСВО	-	50 0	nAdc
ON CHARACTERISTICS			Cumpirt	ttar Ceroff
DC Current Gain (I _C = 3.0 mAdc, V _{CE} = 10 Vdc)	hFE	20	Vdc. <u>1c</u> = 0) ENISVJ CS	PER = 3.0 CHARACT
Base-Emitter On Voltage (IC = 3.0 mAdc, VCE = 10 Vdc)	V _{BE(on)}	lobV t	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I _C = 3.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	fT	400	ter S <u>at</u> uration (do, lg = 1,4 t	MHz
Collector-Emitter Capacitance (V _{CE} = 10 Vdc, I _B = 0, f = 1.0 MHz, base guarded)	C _{ce} (C _{rb})	AUSTINS roduct	0.3	pF
Noise Figure (I _C = 3.0 mAdc, V_{CB} = 10 Vdc, R_{S} = 50 Ohms, f = 100 MHz)	NF W	= 1 <u>ab</u> V 0	3.2	dB
FUNCTIONAL TEST		(sH	/dc, f = 1.0 N	or = 90
Common-Emitter Amplifier Power Gain (IC = 3.0 mAdc, V _{CB} = 10 Vdc, R _S = 50 Ohms, f = 100 MHz) (IC = 3.0 mAdc, V _{CB} = 10 Vdc, R _S = 50 Ohms, f = 200 MHz)	G _{pb}	18 14	area $\frac{1}{\sqrt{CE}} = 1$	dB
Forward AGC Current (Gain Reduction = 30 dB, R _S = 50 Ohms, f = 100 MHz)	IAGC	5.0	8.0	mAdc

AGC CHARACTERISTICS

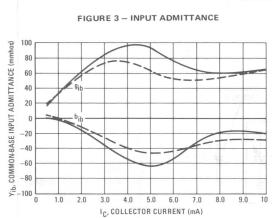
 V_{CC} = 10 Vdc, R_S = 50 Ohms, See Figure 9





COMMON-BASE y PARAMETERS

$$V_{CB} = 10 \text{ Vdc}, T_A = 25^{\circ}\text{C}$$



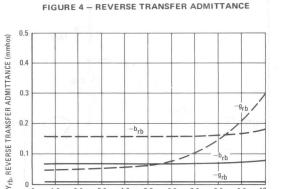
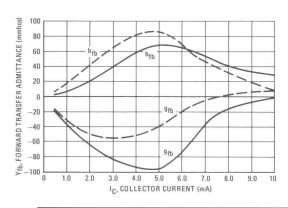


FIGURE 5 - FORWARD TRANSFER ADMITTANCE





5.0

IC, COLLECTOR CURRENT (mA)

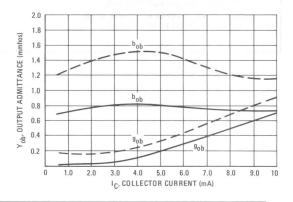
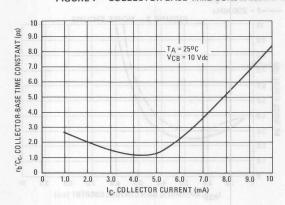




FIGURE 7 - COLLECTOR-BASE TIME CONSTANT OF THE FIGURE 8 - CURRENT-GAIN BANDWIDTH PRODUCT



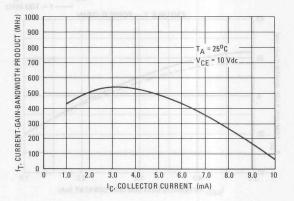
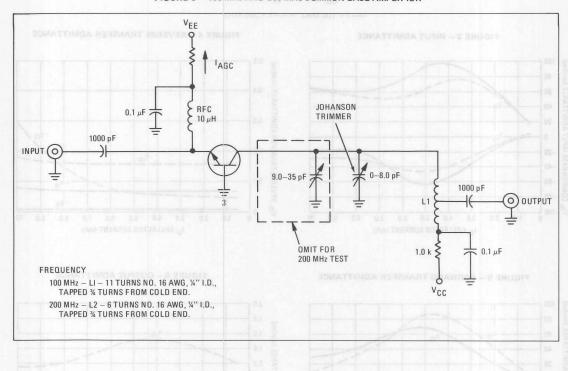


FIGURE 9 - 100-MHz AND 200-MHz COMMON-BASE AMPLIFIER



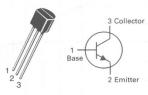
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	25	Vdc
Collector-Base Voltage	VCBO	30	Vdc
Emitter-Base Voltage	VEBO	3.0	Vdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

MPSH10* MPSH11*

CASE 29-04, STYLE 2 TO-92 (TO-226AA)



VHF/UHF TRANSISTORS

NPN SILICON

★These are Motorola designated preferred devices.

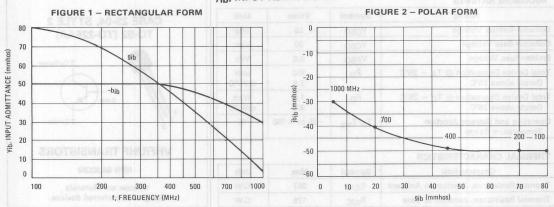
ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	ES APPLICATION OF THE	VINCE TO RELEASE			
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)		V(BR)CEO	25	0.5101	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)		V(BR)CBO	30	= =	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0)		V _{(BR)EBO}	3.0		Vdc
Collector Cutoff Current $(V_{CB} = 25 \text{ Vdc}, I_{E} = 0)$		СВО	_	100	nAdc
Emitter Cutoff Current (V _{EB} = 2.0 Vdc, I _C = 0)		IEBO		100	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 4.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$)		hFE	60	_	Twe
Collector-Emitter Saturation Voltage (I _C = 4.0 mAdc, I _B = 0.4 mAdc)	nael II	V _{CE(sat)}	_	0.5	Vdc
Base-Emitter On Voltage (I _C = 4.0 mAdc, V _{CE} = 10 Vdc)		V _{BE}	_	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS	MARKET BANGEER AND	Vaa .ne			
Current-Gain — Bandwidth Product (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)		fT	650	- a a a r u	MHz
Collector-Base Capacitance ($V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz}$)		C _{cb}	-	0.7	pF
Common-Base Feedback Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	MPS-H10 MPS-H11	C _{rb}	0.35 0.6	0.65 0.9	pF
Collector Base Time Constant (I _C = 4.0 mAdc, V _{CB} = 10 Vdc, f = 31.8 MHz)		rb′C _c	-	9.0	ps

COMMON-BASE y PARAMETERS versus FREQUENCY

 $(V_{CB} = 10 \text{ Vdc}, I_{C} = 4.0 \text{ mAdc}, T_{A} = 25^{\circ}\text{C})$

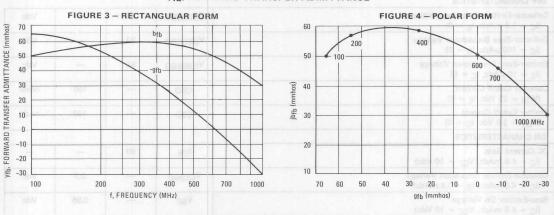
yib, INPUT ADMITTANCE



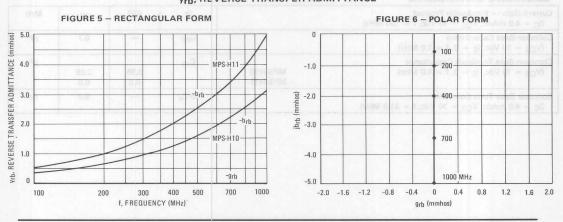
COMMON-BASE y PARAMETERS versus FREQUENCY

 $(V_{CB} = 10 \text{ Vdc}, I_{C} = 4.0 \text{ mAdc}, T_{A} = 25^{\circ}\text{C})$

yfb, FORWARD TRANSFER ADMITTANCE



yrb, REVERSE TRANSFER ADMITTANCE



yob, OUTPUT ADMITTANCE

FIGURE 7 - RECTANGULAR FORM

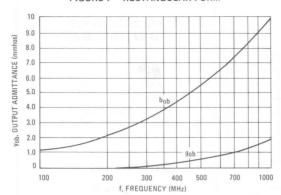
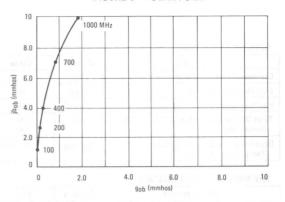


FIGURE 8 - POLAR FORM



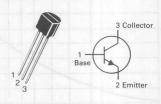
TO DESIGNATION TO COMPANY			
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	15	Vdc
Collector-Base Voltage	VCBO	20	Vdc
Emitter-Base Voltage	VEBO	3.0	Vdc
Total Device Dissipation @ $T_A = 25$ °C Derate above 25°C	PD	350 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient (Printed Circuit Board Mounting)	$R_{\theta JA}$	357	°C/W

MPSH17*

CASE 29-04, STYLE 2 TO-92 (TO-226AA)



CATV TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	V _(BR) CEO	15		-	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	V(BR)CBO	20	-		Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V(BR)EBO	3.0	-		Vdc
Collector Cutoff Current $(V_{CB} = 15 \text{ Vdc}, I_E = 0)$	ІСВО	-	_	100	nAdc
ON CHARACTERISTICS		THI			
DC Current Gain (I _C = 5.0 mAdc, V _{CE} = 10 Vdc)	hFE	25	-	250	-
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	V _{CE(sat)}	177	-	0.5	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	fT	800	_	-	MHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, f = 1.0 MHz)	C _{cb}	0.3	-	0.9	pF
Small-Signal Current Gain (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	h _{fe}	30		-	_
Noise Figure (I _C = 5.0 mAdc, V_{CC} = 12 Vdc, R_S = 50 ohms, f = 200 MHz)	NF	-	-	6.0	dB
FUNCTIONAL TEST					
Amplifier Power Gain (I _C = 5.0 mAdc, V_{CC} = 12 Vdc, R_S = 50 ohms, f = 200 MHz)	G _{pe}	- 1	24	- -	dB

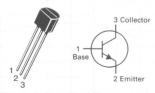
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	30	Vdc
Collector-Base Voltage	VCBO	40	Vdc
Emitter-Base Voltage	VEBO	4.0	Vdc
Collector Current — Continuous	IC	100	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.81	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0 8.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	125	°C/W

MPSH20*

CASE 29-04, STYLE 2 TO-92 (TO-226AA)



VHF TRANSISTOR

NPN SILICON

★This is a Motorola
designated preferred device.

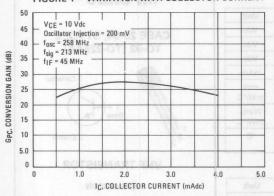
Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	V(BR)CEO	30			Vdc
Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0)	V _(BR) CBO	40		_	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V(BR)EBO	4.0			Vdc
Collector Cutoff Current $(V_{CB} = 15 \text{ Vdc}, I_E = 0)$	ІСВО	_	-	50	nAdc
ON CHARACTERISTICS	+				
DC Current Gain (IC = 4.0 mAdc, VCE = 10 Vdc)	hFE	25	_		
SMALL-SIGNAL CHARACTERISTICS	ites in t	Pi	Hit It	9 0 -	Tib
Current-Gain — Bandwidth Product (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	fT	400	620	_	MHz
Collector-Base Capacitance $(V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz})$	C _{cb}	9 -	0.5	0.65	pF
Collector Base Time Constant (I _E = 4.0 mAdc, V _{CB} = 10 Vdc, f = 31.8 MHz)	rb′C _C	0.5	10	_	ps
Conversion Gain (213 to 45 MHz) (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, Oscillator Injection = 200 mVdc)	GC	18	23		dB

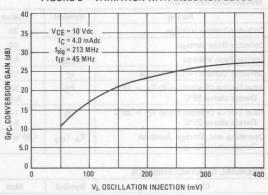
CONVERSION GAIN CHARACTERISTICS

(TEST CIRCUIT FIGURE 9)



FIGURE 2 - VARIATION WITH INJECTION LEVEL



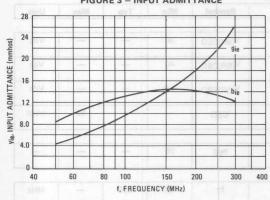


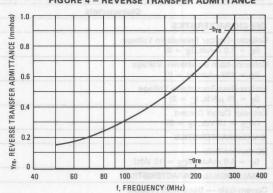
COMMON-EMITTER y PARAMETERS

 $(I_C = 4.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, T_A = 25^{\circ}\text{C})$

FIGURE 3 - INPUT ADMITTANCE

FIGURE 4 - REVERSE TRANSFER ADMITTANCE



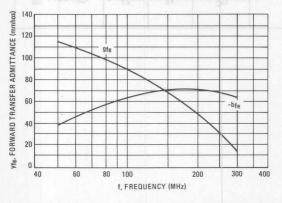


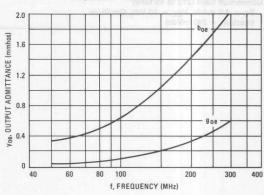
COMMON-EMITTER y PARAMETERS

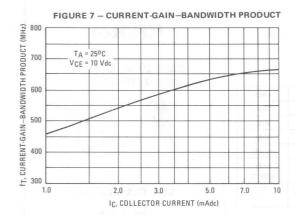
(IC = 4.0 mAdc, VCE = 10 Vdc, TA = 25°C)

FIGURE 5 - FORWARD TRANSFER ADMITTANCE

FIGURE 6 - OUTPUT ADMITTANCE







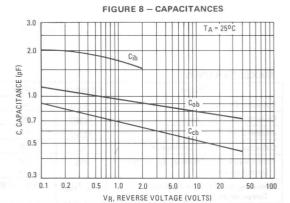
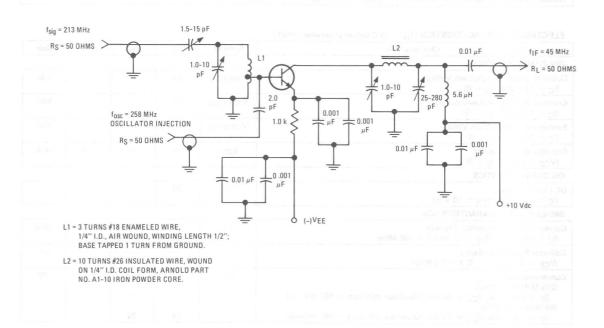


FIGURE 9 - MIXER TEST CIRCUIT



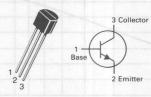
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	30	Vdc
Collector-Base Voltage	VCBO	40	Vdc
Emitter-Base Voltage	VEBO	4.0	Vdc
Collector Current — Continuous	Ic	50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +135	ni °C ni

THERMAL CHARACTERISTICS

THE HIMAE OHAHAOTEHIOTIOO			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	RAIA	357	°C/W

MPSH24

CASE 29-04, STYLE 2 TO-92 (TO-226AA)



VHF TRANSISTOR

NPN SILICON

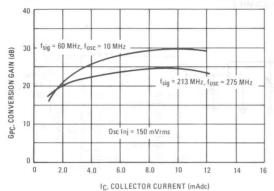
Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	10 g 11 m	0.1			
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	V(BR)CEO	30	-	-	Vdc
Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0)	V(BR)CBO	40	HW 825 - 444	-	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V(BR)EBO	4.0	R07A1 H381	- 1	Vdc
Collector Cutoff Current (VCB = 15 Vdc, IE = 0)	ІСВО	7-	-	50	nAdc
ON CHARACTERISTICS	100.0 L 30.10 A				
DC Current Gain (I _C = 8.0 mAdc, V _{CE} = 10 Vdc)	hFE	30	_	-76	-
SMALL-SIGNAL CHARACTERISTICS		Total Gill			
Current-Gain — Bandwidth Product (I _C = 8.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	fT	400	620	F SUR ₩ 5 × 1 A . 0.1 *N3	MHz
Collector-Base Capacitance $(V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz})$	C _{cb}	EW JERWICE, WIS	0.25	0.36	pF
Conversion Gain (213 MHz to 45 MHz) (I _C = 8.0 mAdc, V _{CC} = 20 Vdc, Oscillator Injection = 150 mVrr (60 MHz to 45 MHz)	G _C	19	24		dB
(I _C = 8.0 mAdc, V _{CC} = 20 Vdc, Oscillator Injection = 150 mVrr	ms)	24	29	_	

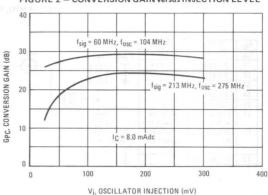
CONVERSION GAIN CHARACTERISTICS

(TEST CIRCUIT FIGURE 7)

 $(V_{CC} = 20 \text{ Vdc}, R_S = R_L = 50 \text{ Ohms}, f_{if} = 44 \text{ MHz}, B.W. = 6.0 \text{ MHz})$

FIGURE 1 - CONVERSION GAIN versus COLLECTOR CURRENT FIGURE 2 - CONVERSION GAIN versus INJECTION LEVEL





COMMON-EMITTER y PARAMETERS

 $(V_{CE} = 15 \text{ Vdc}, T_A = 25^{\circ}\text{C})$

FIGURE 3 - INPUT ADMITTANCE

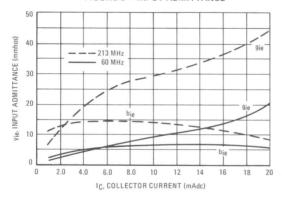


FIGURE 4 - REVERSE TRANSFER ADMITTANCE

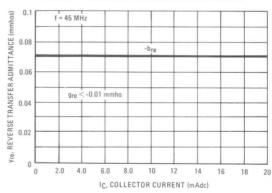


FIGURE 5 - FORWARD TRANSFER ADMITTANCE

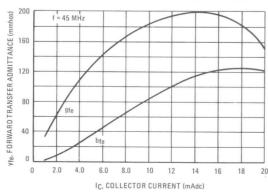


FIGURE 6 - OUTPUT ADMITTANCE

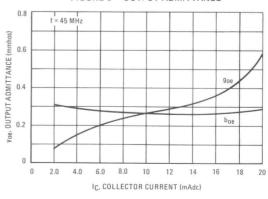
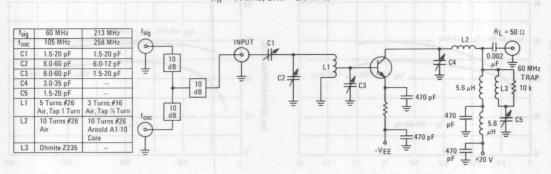
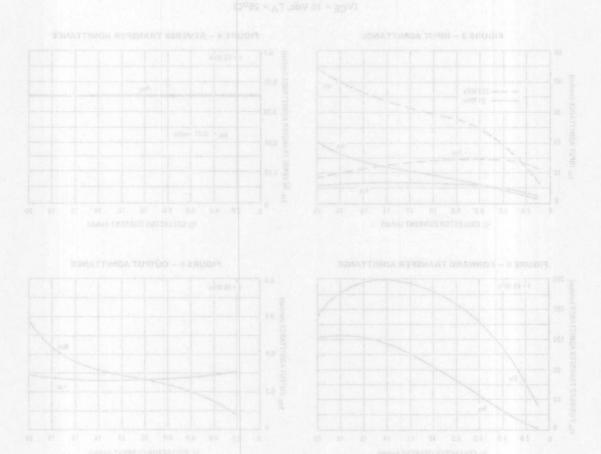


FIGURE 7 - VHF MIXER TEST CIRCUIT

(f_{if} = 44 MHz, B.W. = 6.0 MHz)





Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	V _{CBO}	40	Vdc
Emitter-Base Voltage	V _{EBO}	4.0	Vdc
Collector Current — Continuous	lc	50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

MPSH34 CASE 29-04, STYLE 2 TO-92 (TO-226AA) 3 Collector 1 Base 2 Emitter IF TRANSISTOR NPN SILICON

Refer to MPSH24 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Charac	teristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS				2	Jr L	101 D PI
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	ar Lundham	V(BR)CEO	40	(0 (19.A - 1 9.00)	5512 <u>-</u> 111	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc, I_E = 0$)	3 - 5-4, gs X	V(BR)CBO	40	y V _Q i ng u	g	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)	UL SHUB (S)	V(BR)EBO	4.0	91.0 <u>0.0</u> V.10	91- <u>-</u>	Vdc
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0)	0718	ІСВО	_	-	50	nAdc
ON CHARACTERISTICS						M CHAIL
DC Current Gain $ \begin{aligned} &(I_C = 7.0 \text{ mAdc, } V_{CE} = 15 \text{ Vdc)} \\ &(I_C = 20 \text{ mAdc, } V_{CE} = 2.0 \text{ Vdc)} \end{aligned} $	ia ayê	hFE	40 15	13I -		LI LAW
Collector-Emitter Saturation Voltage $(I_C = 7.0 \text{ mAdc}, I_B = 2.0 \text{ mAdc})$	acia - ya	VCE(sat)	<u> </u>	11. (** 1) 11. (**	0.5	Vdc
Base-Emitter On Voltage ($I_C = 7.0 \text{ mAdc}$, $V_{CE} = 15 \text{ Vdc}$)		V _{BE(on)}	12000		0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I _C = 15 mAdc, V _{CE} = 15 Vdc, f = 1	00 MHz)	fT	500	720	_	MHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		C _{cb}	_	0.25	0.32	pF

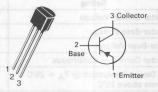
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	alay - 15	Vdc
Collector-Base Voltage	VCBO	56V - 15	Vdc
Emitter-Base Voltage	VEBO	plaArri-4	□ Vdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.81	mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

MPSH69*

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



RF AMPLIFIER TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					CTENSTICS	ARAHO 19
Collector-Emitter Breakdown Voltage (I _C = -1.0 mAdc, I _B = 0)	REIV .	V(BR)CEO	- 15	wn Voltage	oites o veskel mAdo. le = f	Vdc
Collector-Base Breakdown Voltage (I _C = -10 µAdc, I _E = 0)	яв)У	V(BR)CBO	- 15	Volume	se Br u ndown uAdo, 'p' = 1	Vdc
Emitter-Base Breakdown Voltage (I _E = -10 µAdc, I _C = 0)	яв)У	V(BR)EBO	-4	ugustoV	a Brasildovid	Vdc
Collector Cutoff Current (V _{CB} = -10 Vdc, I _E = 0)	rof l	ICBO		_	-100	nAdc
ON CHARACTERISTICS					ейтелето	и снава
DC Current Gain (I _C = -10 mAdc, V _{CE} = -10 Vdc)	pit	hFE	30	16 Vdc)	300	Corrent (Ic = 7.0
SMALL-SIGNAL CHARACTERISTICS				2.0 Vdc)	# ggV alb/ar	(tc = 20 r
Current-Gain — Bandwidth Product (I _C = -10 mAdc, V _{CE} = -10 Vdc, f = 100 MHz)	VCE	fT	2000	on V <u>ol</u> rage .c mAde)	litter <u>S</u> haral I — gliobha	MHz
Collector-Base Capacitance (V _{CE} = -10 Vdc, I _E = 0, f = 1.0 MHz)	Ves	C _{rb}		15 Vdc)	0.3	pF

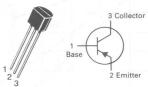
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-20	Vdc
Collector-Base Voltage	V _{CBO}	-20	Vdc
Emitter-Base Voltage	VEBO	-3.0	Vdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

MPSH81*

CASE 29-04, STYLE 2 TO-92 (TO-226AA)



RF AMPLIFIER TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = -1.0 mAdc, I _B = 0)	V _(BR) CEO	-20	-		Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc$, $I_E = 0$)	V _(BR) CBO	-20	J	_	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc, I_C = 0$)	V _{(BR)EBO}	-3.0	=	_	Vdc
Collector Cutoff Current $(V_{CB} = -10 \text{ Vdc}, I_{E} = 0)$	ICBO	-		-100	nAdc
Emitter Cutoff Current $(V_{EB} = -2.0 \text{ Vdc}, I_{C} = 0)$	IEBO	-1	-	-100	nAdc
ON CHARACTERISTICS					1
DC Current Gain (I _C = -5.0 mAdc, V _{CE} = -10 Vdc)	hFE	60			- Ist-
Collector-Emitter Saturation Voltage ($I_C = -5.0 \text{ mAdc}$, $I_B = -0.5 \text{ mAdc}$)	V _{CE(sat)}	_	- , - ,	-0.5	Vdc
Base-Emitter On Voltage (I _C = -5.0 mAdc, V _{CE} = -10 Vdc)	V _{BE(on)}	_	_	-0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = -5.0 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$, $f = 100 \text{ MHz}$)	fT	600	_	_	MHz
Collector-Base Capacitance ($V_{CB} = -10 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C _{cb}		_	0.85	pF
Collector-Emitter Capacitance (I _B = 0, V _{CB} = -10 Vdc, f = 1.0 MHz	C _{ce}		_	0.65	pF

TYPICAL COMMON-BASE y-PARAMETERS

(V_{CB} = 10 Vdc, T_A = 25^oC, Frequency Points in MHz)

FIGURE 1 - INPUT ADMITTANCE

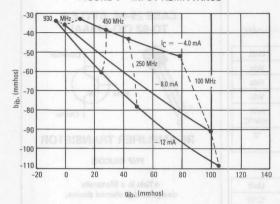


FIGURE 2 - REVERSE TRANSFER ADMITTANCE

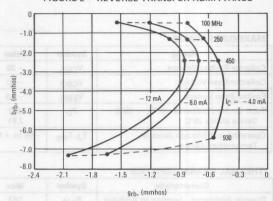


FIGURE 3 - FORWARD TRANSFER ADMITTANCE

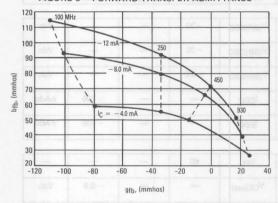


FIGURE 4 - OUTPUT ADMITTANCE

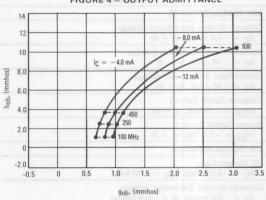
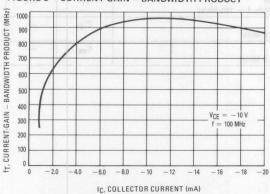


FIGURE 5 - CURRENT-GAIN - BANDWIDTH PRODUCT

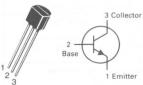


Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	120	Vdc
Collector-Base Voltage	VCBO	140	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	IC	150	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

THE HIMAE OHAHACTEHIOTIOO			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta,IC}$	83.3	°C/W

MPSL01 CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N5550 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS			31	V. A143 A
Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0)	V(BR)CEO	120	-	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc$, $I_E = 0$)	V(BR)CBO	140	_	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V(BR)EBO	5.0	/ _ Au	Vdc
Collector Cutoff Current (V _{CB} = 75 Vdc, I _E = 0)	ІСВО) _	1.0	μAdc
Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0)	IEBO	_	100	nAdc
ON CHARACTERISTICS				1803
DC Current Gain(1) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc)	hFE	50	300	
Collector-Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}$, $I_B = 1.0 \text{ mAdc}$) ($I_C = 50 \text{ mAdc}$, $I_B = 5.0 \text{ mAdc}$)	VCE(sat)	_	0.20 0.30	Vdc
Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc)(1)	V _{BE} (sat)		1.2 1.4	Vdc
SMALL-SIGNAL CHARACTERISTICS		3 1 V V VIS	1 182-7	JER DE
Current-Gain — Bandwidth Product(1) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 20 MHz)	fT	60	-	MHz
Collector-Base Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C _{cb}		8.0	pF
Small-Signal Current Gain (IC = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h _{fe}	30		

⁽¹⁾ Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

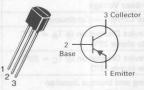
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-100	Vdc
Collector-Base Voltage	V _{CBO}	-100	Vdc
Emitter-Base Voltage	V _{EBO}	-4.0	Vdc
Collector Current — Ctoninuous	Ic	-600	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

THE THINK OHAHAOTE HOTTOO			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

MPSL51

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N5400 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Chara	cteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				earteaun	DARABO
Collector-Emitter Breakdown Voltage(1) $(I_C = -1.0 \text{ mAdc}, 1_B = 0)$	VIBRICEO	V _{(BR)CEO}	-100	vobsteen8 res	Vdc
Collector-Base Breakdown Voltage ($I_C = -100 \mu Adc, I_E = 0$)	OBOURSIV .	V(BR)CBO	- 100	Constitutions for a selection	Vdc
Emitter-Base Breakdown Voltage (I _E = -10μ Adc, I _C = 0)	oea(nin) ^V	V(BR)EBO	-4.0	V mwoodseal	Vdc
Collector Cutoff Current (V _{CB} = -50 Vdc, I _E = 0)	10830	Ісво	-	-1.0	μAdd
Emitter Cutoff Current (VEB = -3.0 Vdc, I _C = 0)	oaal	IEBO	-	-100	nAdd
ON CHARACTERISTICS(1)				entren3	CORRACT
DC Current Gain(1) (I _C = -50 mAdc, V _{CE} = -5.0 Vdc)	or gaption .	hFE	40	250	or DI =
Collector-Emitter Saturation Voltage ($I_C = -10$ mAdc, $I_B = -1.0$ mAdc) ($I_C = -50$ mAdc, $I_B = -5.0$ mAdc)	(teal)EOV	VCE(sat)	egullov i mau lii mAu lii	-0.25 -0.30	Vdc
Base-Emitter Saturation Voltage ($I_C = -10$ mAdc, $I_B = -1.0$ mAdc) ($I_C = -50$ mAdc, $I_B = -5.0$ mAdc)	VSE(set)	V _{BE(sat)}	sgati TanAm UtilahAm	-1.2 -1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS			earrene	TOARAND LA	Male-11
Current-Gain — Bandwidth Product $(I_C = -10 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}, f = -10 \text{ Vdc})$	= 20 MHz)	f _T	60	dibliwidina8 - lute, White =	MHz
Output Capacitance $(V_{CB} = -10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz})$:)	C _{obo}	(shift) 0.r =	8.0	pF
Small-Signal Current Gain (IC = -1.0 mAdc, VCE = -10 Vdc, f	= 1.0 kHz)	h _{fe}	20	Convert Gain	isngi d -li

(1) Pulse Test: Pulse Test = 300 μ s, Duty Cycle = 2.0%.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage MPSW01 MPSW01A	VCEO	30 40	Vdc
Collector-Base Voltage MPSW01 MPSW01A	VCBO	40 50	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	IC	1000	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta,JC}$	50	°C/W

CASE 29-05, STYLE 1
TO-92 (TO-226AE)

3 Collector
1 Emitter
ONE WATT
HIGH CURRENT TRANSISTORS
NPN SILICON

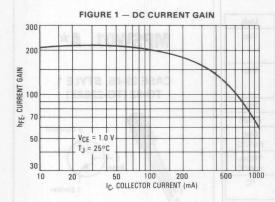
★MPSW01A is a Motorola designated preferred device.

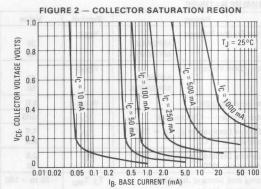
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

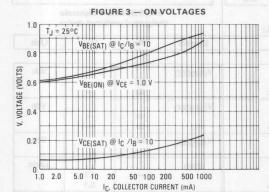
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	- In a				180
Collector-Emitter Breakdown Voltage(1) $(I_C = 10 \text{ mAdc}, I_B = 0)$	MPSW01 MPSW01A	V(BR)CEO	30 40	=	Vdc
Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0)	MPSW01 MPSW01A	V(BR)CBO	40 50	_	Vdc
Emitter-Base Breakdown Voltage (IE = 100 μ Adc, IC = 0)		V _{(BR)EBO}	5.0		Vdc
Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0) (V _{CB} = 40 Vdc, I _E = 0)	MPSW01 MPSW01A	Ісво	14 h	0.1 0.1	μAdc
Emitter Cutoff Current (V _{EB} = 3.0 Vdc, I _C = 0)	>	IEBO	_	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I _C = 10 mAdc, V_{CE} = 1.0 Vdc) (I _C = 100 mAdc, V_{CE} = 1.0 Vdc) (I _C = 1000 mAdc, V_{CE} = 1.0 Vdc)		hFE	55 60 50	=	_
Collector-Emitter Saturation Voltage (I _C = 1000 mAdc, I _B = 100 mAdc)		V _{CE(sat)}	_	0.5	Vdc
Base-Emitter On Voltage (I _C = 1000 mAdc, V _{CE} = 1.0 Vdc)	raudor	V _{BE(on)}	MI (See Yor.	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz)		fT	50	_	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}		20	pF

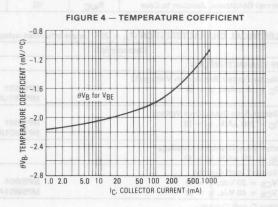
(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

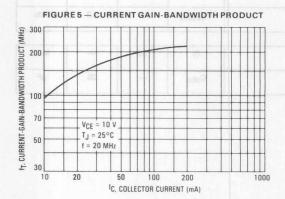
MPSW01, A

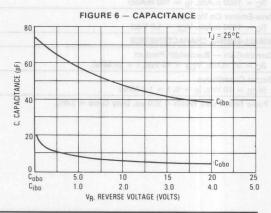


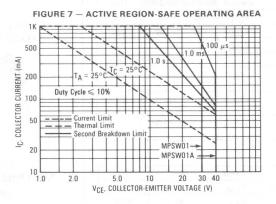












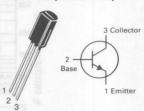
na bunioni ibiniteo				
Rating	Symbol	MPSW05	MPSW06	Unit
Collector-Emitter Voltage	VCEO	60	80	Vdc
Collector-Base Voltage	VCBO	60	80	Vdc
Emitter-Base Voltage	VEBO	4	.0	Vdc
Collector Current — Continuous	Ic	500		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20		Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to	+ 150	°C

THERMAL CHARACTERISTICS

THE HITTE OF PARTY OF ENDOTION				
Characteristic	Symbol	Max	Unit	
Thermal Resistance, Junction to Ambient	$R_{\theta}JA$	125	°C/W	
Thermal Resistance, Junction to Case	RAIC	50	°C/W	

MPSW05

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

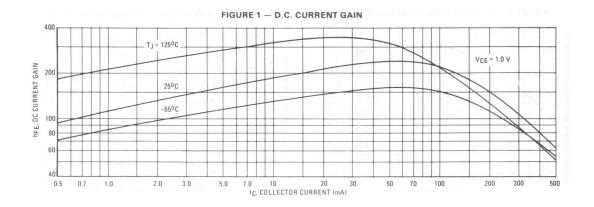
NPN SILICON

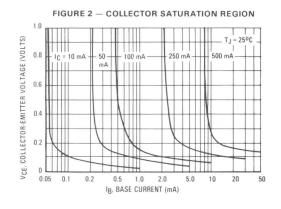
★This is a Motorola designated preferred device.

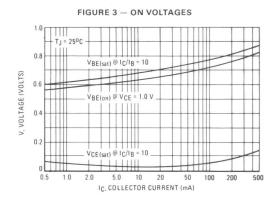
ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

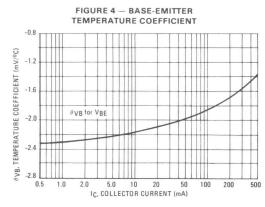
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0)	MPSW05 MPSW06	V(BR)CEO	60 80	=	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \ \mu Adc, I_C = 0$)		V(BR)EBO	4.0	-	Vdc
Collector Cutoff Current $(V_{CE} = 40 \text{ Vdc}, I_B = 0)$ $(V_{CE} = 60 \text{ Vdc}, I_B = 0)$	MPSW05 MPSW06	ICES	=	0.5 0.5	μAdc
Collector Cutoff Current (V _{CB} = 40 Vdc, I _E = 0) (V _{CB} = 60 Vdc, I _E = 0)	MPSW05 MPSW06	ІСВО	=	0.1 0.1	μAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0)		IEBO	-	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I _C = 50 mAdc, V_{CE} = 1.0 Vdc) (I _C = 250 mAdc, V_{CE} = 1.0 Vdc)		hFE	80 60	=	-
Collector-Emitter Saturation Voltage (I _C = 250 mAdc, I _B = 10 mAdc)		V _{CE(sat)}	_	0.40	Vdc
Base-Emitter Saturation Voltage (I _C = 250 mAdc, V _{CE} = 5.0 Vdc)		V _{BE(sat)}	-	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = 200 mAdc, V _{CE} = 5.0 Vdc, f = 20 MHz)		fT	50	-	MHz
Output Capacitance (V _{CB} = 10 V, f = 1.0 MHz)		C _{obo}	-	12	pF

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.









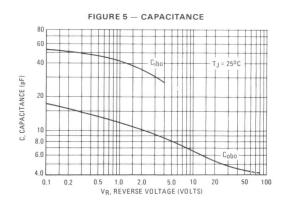
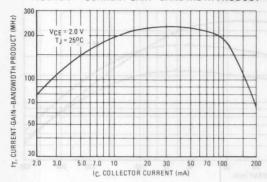
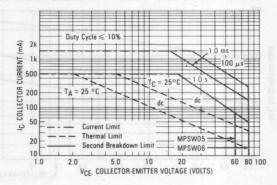
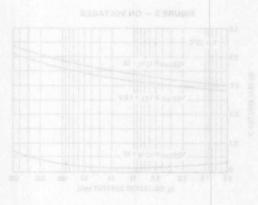
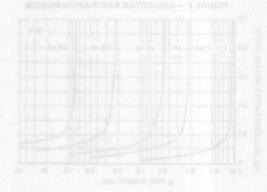


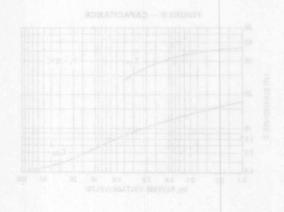
FIGURE 6 - CURRENT GAIN - BANDWIDTH PRODUCT FIGURE 7 - ACTIVE REGION - SAFE OPERATING AREA

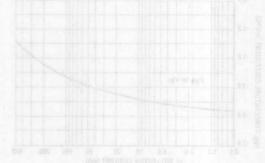












The Control of the Co				
Rating	Symbol	Value	Unit	
Collector-Emitter Voltage	VCEO	300	Vdc	
Collector-Base Voltage	V _{CBO}	300	Vdc	
Emitter-Base Voltage	V _{EBO}	6.0	Vdc	
Collector Current — Continuous	Ic	500	mAdc	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C	
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20	Watts mW/°C	
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C	

THERMAL CHARACTERISTICS

THEMMAL CHAMACTEMOTICS			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

MPSW10 **CASE 29-05, STYLE 1** TO-92 (TO-226AE) **ONE WATT**

HIGH VOLTAGE TRANSISTOR

NPN SILICON

Refer to MPSW42 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS				EDITED Y	0.65 0 - 10 2
Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0)		V(BR)CEO	300	ot so <u>u</u>	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc$, $I_E = 0$)		V(BR)CBO	300		Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)		V(BR)EBO	6.0	70 <u>00</u> 1 = 31 1	Vdc
Collector Cutoff Current (V _{CB} = 200 Vdc, I _E = 0)		ІСВО	_	0.2	μAdc
Emitter Cutoff Current (V _{EB} = 6.0 Vdc, I _C = 0)	PLANE AND	IEBO	<u>ab</u> V 0 -	0.1	μAdc
ON CHARACTERISTICS(1)	empath.		comment S		- Jill Rii
DC Current Gain (I _C = 1.0 mAdc, V_{CE} = 10 Vdc) (I _C = 10 mAdc, V_{CE} = 10 Vdc) (I _C = 30 mAdc, V_{CE} = 10 Vdc)		hFE	25 40 40	omite ^s e	
Collector-Emitter Saturation Voltage (I _C = 30 mAdc, I _B = 3.0 mAdc)		V _{CE} (sat)	= 68	0.75	Vdc
Base-Emitter On Voltage (I _C = 30 mAdc, V _{CE} = 10 Vdc)		V _{BE} (on)	(Excurs As	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS		* 4.V (101)		30 . 1 .	1 = 00
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 20 MHz)		fT	45	rifisiVV ne.	MHz
Collector-Base Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 1.0 MHz)		C _{cb}		3.0	pF
ND 1 T . D 1 NOTE 11				_	

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

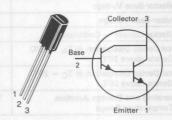
B 41	0 1 1	Value	Unit
Rating	Symbol	value	Unit
Collector-Emitter Voltage	VCES	30	Vdc
Collector-Base Voltage	VCBO	30	Vdc
Emitter-Base Voltage	VEBO	10	Vdc
Collector Current — Continuous	Ic	1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	50	°C/W

MPSW14

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



ONE WATT DARLINGTON TRANSISTORS

NPN SILICON

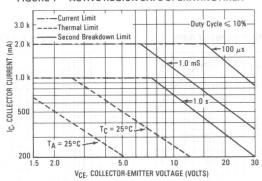
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

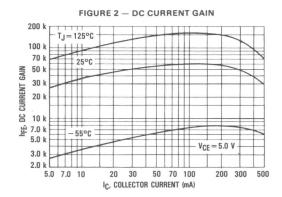
thru kath cha	racteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					TENSHES	DARAKO F
Collector-Emitter Breakdown Voltage (I _C = 100 µAdc, V _{BE} = 0)	VIBRICEO		V(BR)CES	30	tter (skdo Adc. igi = 0	Vdc
Collector Cutoff Current (VCB = 30 Vdc, I _E = 0)	У(ав)сво		ІСВО	Voltage	100	nAdc
Emitter Cutoff Current (VEB = 10 Vdc, I _C = 0)	OBE(SE)V		I _{EBO}	*oltage	100	nAdc
ON CHARACTERISTICS(1)	osal				arrents The	finetor Curc
DC Current Gain ($I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc}$)		MPSW13 MPSW14	hFE	5000 10,000		v <u>ca</u> = 20 litter Cutol Veg = 8.0
$(I_C = 100 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$		MPSW13 MPSW14		10,000 20,000	nia alin	U CHARAC Current C
Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 0.1 mAdc)			V _{CE(sat)}	(0 Vdc)	1.5	Vdc
Base-Emitter On Voltage (I _C = 100 mAdc, V _{CE} = 5.0 Vdc)	(tne)50V		V _{BE(on)}	egalloV na	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS	A. Service				nestleV of	softler 3-mi
Current-Gain — Bandwidth Product(2) (IC = 10 mAdc, VCF = 5.0 Vdc, f =	100 MHz)		fT	125 / 07	e gg u abê	MHz

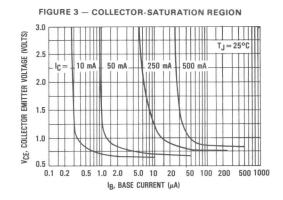
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

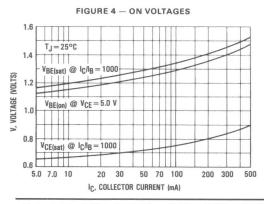
⁽²⁾ $f_T = |h_{fe}| \cdot f_{test}$.

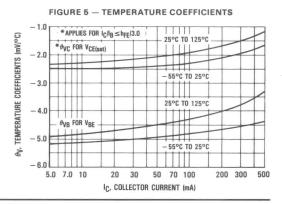
FIGURE 1 — ACTIVE REGION SAFE OPERATING AREA

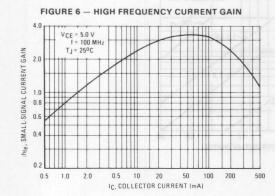


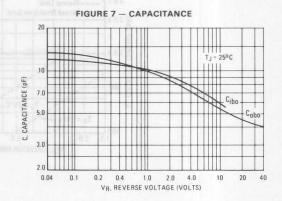


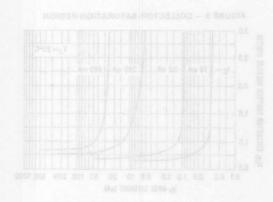


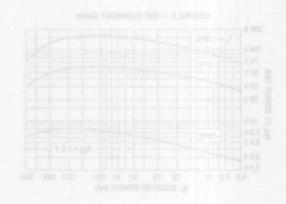


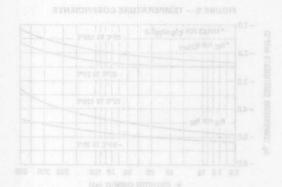


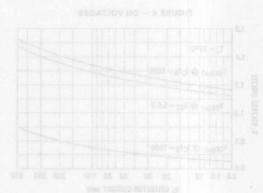












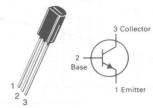
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	300	Vdc
Collector-Base Voltage	V _{CBO}	300	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	IC	500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

THE THAT OF A TANGET OF			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	R _B JC	50	°C/W

MPSW42*

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



ONE WATT HIGH VOLTAGE TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Symbol	Min	Max	Unit
V(BR)CEO	300	_	Vdc
V(BR)CBO	300	_	Vdc
V(BR)EBO	6.0	_	Vdc
Ісво		0.1	μAdc
I _{EBO}	<u>-</u>	0.1	μAdc
hFE	25 40 40		_
VCE(sat)	×	0.5	Vdc
V _{BE} (sat)	_	0.9	Vdc
92 01A 73	3/195	k Darlin Co	
fτ	50	-	MHz
C _{cb}		3.0	pF
	V(BR)CEO V(BR)CBO V(BR)EBO ICBO IEBO VCE(sat) VBE(sat)	V(BR)CEO 300 V(BR)CBO 300 V(BR)EBO 6.0 ICBO — IEBO — VCE(sat) — VBE(sat) — fT 50	V(BR)CEO 300 — V(BR)CBO 300 — V(BR)EBO 6.0 — ICBO — 0.1 IEBO — 0.1 MFE 25 — 40 — VCE(sat) — 0.5 VBE(sat) — 0.9

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

MPSW42



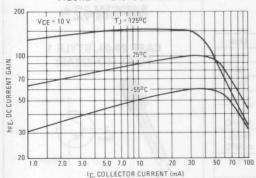


FIGURE 2 — COLLECTOR SATURATION REGION

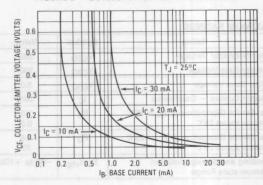


FIGURE 3 - ON VOLTAGES

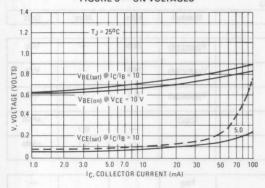


FIGURE 4 — TEMPERATURE COEFFICIENTS

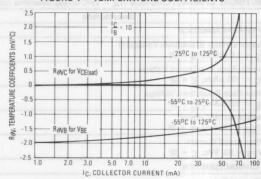


FIGURE 5 - CAPACITANCE

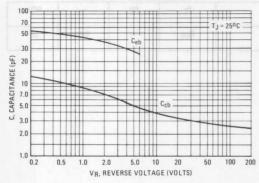


FIGURE 6 — CURRENT GAIN - BANDWIDTH PRODUCT

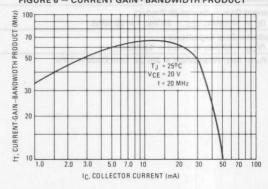
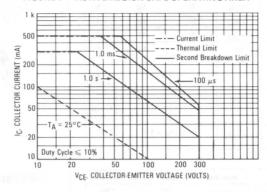


FIGURE 7 — ACTIVE REGION SAFE OPERATING AREA



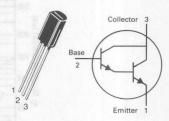
Rating	Symbol	MPSW45	MPSW45A	Unit
Collector-Emitter Voltage	VCES	40	50	Vdc
Collector-Base Voltage	VCBO	50	60	Vdc
Emitter-Base Voltage	VEBO	12	12	Vdc
Collector Current — Continuous	Ic	1.0	1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD		2.5	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 t	o +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

MPSW45,A*

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



ONE WATT DARLINGTON TRANSISTORS

NPN SILICON

★MPSW45A is a Motorola designated preferred device.

Refer to 2N6426 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (IC = 100 μ Adc, VBE = 0)	MPSW45 MPSW45A	V(BR)CES	40 50	=	Vdc
Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0)	MPSW45 MPSW45A	V _(BR) CBO	50 60	Ξ	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0)		V _{(BR)EBO}	12	-	Vdc
Collector Cutoff Current $(V_{CB} = 30 \text{ Vdc}, I_E = 0)$ $(V_{CB} = 40 \text{ Vdc}, I_E = 0)$	MPSW45 MPSW45A	СВО	Ξ	100 100	nAdc
Emitter Cutoff Current (V _{EB} = 10 Vdc, I _C = 0)		I _{EBO}	-	100	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I _C = 200 mAdc, V_{CE} = 5.0 Vdc) (I _C = 500 mAdc, V_{CE} = 5.0 Vdc) (I _C = 1.0 Adc, V_{CE} = 5.0 Vdc)		hFE	25,000 15,000 4,000	150,000	-
Collector-Emitter Saturation Voltage (I _C = 1.0 Adc, I _B = 2.0 mAdc)		V _{CE(sat)}		1.5	Vdc
Base-Emitter Saturation Voltage (I _C = 1.0 Adc, I _B = 2.0 mAdc)		V _{BE(sat)}		2.0	Vdc
Base-Emitter On Voltage (I _C = 1.0 Adc, V _{CE} = 5.0 Vdc)		V _{BE(on)}		2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = 200 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz)		fT	100		MHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		C _{cb}	-	6.0	pF

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Kating		Symbol	Value	Unit
Collector-Emitter Voltage	MPSW51 MPSW51A	VCEO	-30 -40	Vdc
Collector-Base Voltage	MPSW51 MPSW51A	V _{CBO}	-40 -50	Vdc
Emitter-Base Voltage		VEBO	-5.0	Vdc
Collector Current — Cont	inuous	IC	- 1000	mAdc
Total Device Dissipation Derate above 25°C	$@ T_A = 25^{\circ}C$	PD	1.0 8.0	Watt mW/°C
Total Device Dissipation Derate above 25°C	$@ T_C = 25^{\circ}C$	PD	2.5	Watts mW/°C
Operating and Storage Jo Temperature Range	unction	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W



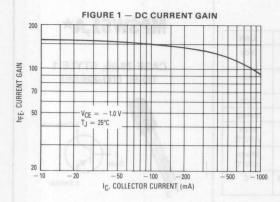
PNP SILICON

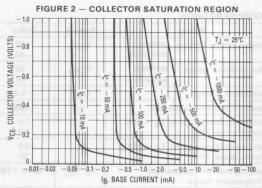
★MPSW51A is a Motorola designated preferred device.

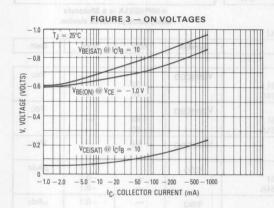
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

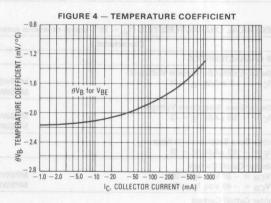
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	FIELD & Mith	THE PAR			
Collector-Emitter Breakdown Voltage(1) $(I_C = -1.0 \text{ mAdc}, I_B = 0)$	MPSW51 MPSW51A	V _(BR) CEO	-30 -40		Vdc
Collector-Base Breakdown Voltage (IC = $-100~\mu \text{Adc}$, IE = 0)	MPSW51 MPSW51A	V(BR)CBO	-40 -50	_	Vdc
Emitter-Base Breakdown Voltage ($I_E = -100 \mu Adc, I_C = 0$)		V(BR)EBO	-5.0	_	Vdc
Collector Cutoff Current $(V_{CB} = -30 \text{ Vdc}, I_E = 0)$ $(V_{CB} = -40 \text{ Vdc}, I_E = 0)$	MPSW51 MPSW51A	Ісво		-0.1 -0.1	μAdc
Emitter Cuttoff Current $(V_{EB} = -3.0 \text{ Vdc}, I_{C} = 0)$		IEBO	_	-0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain		hFE	55 60 50		_
Collector-Emitter Saturation Voltage (I _C = -1000 mAdc, I _B = -100 mAdc)		VCE(sat)	_	-0.7	Vdc
Base-Emitter On Voltage ($I_C = -1000 \text{ mAdc}$, $V_{CE} = -1.0 \text{ Vdc}$)		V _{BE(on)}	W. 11 20 Table	-1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I _C = -50 mAdc, V _{CE} = -10 Vdc, f = 20 MHz)		fT	50	_	MHz
Output Capacitance (VCB = -10 Vdc, IF = 0, f = 1.0 MHz)	1 1	C _{obo}		30	pF

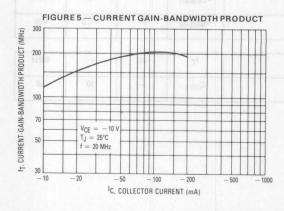
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.











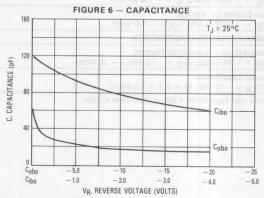
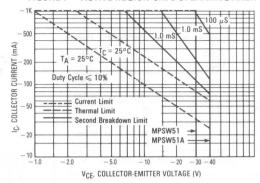


FIGURE 7 — ACTIVE REGION-SAFE OPERATING AREA



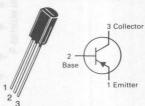
Rating	Symbol	MPSW55	MPSW56	Unit
Collector-Emitter Voltage	VCEO	-60	-80	Vdc
Collector-Base Voltage	VCBO	-60	-80	Vdc
Emitter-Base Voltage	VEBO	444-	4.0	Vdc
Collector Current — Continuous	Ic	-500		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20		Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

MPSW55 MPSW56*

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

PNP SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) $(I_C = -1.0 \text{ mAdc}, I_B = 0)$	MPSW55 MPSW56	V(BR)CEO	-60 -80	=	Vdc
Emitter-Base Breakdown Voltage (I _E = -100μ Adc, I _C = 0)		V(BR)EBO	-4.0	-	Vdc
	MPSW55 MPSW56	ICES	_	-0.5 -0.5	μAdc
Collector Cutoff Current $(V_{CB} = -40 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = -60 \text{ Vdc}, I_{E} = 0)$	MPSW55 MPSW56	ІСВО	= =	-0.1 -0.1	μAdc
Emitter Cutoff Current (VEB = -3.0 Vdc, I _C = 0)		I _{EBO}		-0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I _C = -50 mAdc, V _{CE} = -1.0 Vdc) (I _C = -250 mAdc, V _{CE} = -1.0 Vdc)		hFE	100 50		-
Collector-Emitter Saturation Voltage (I _C = -250 mAdc, I _B = -10 mAdc)		VCE(sat)	-	-0.5	Vdc
Base-Emitter On Voltage (I _C = -250 mAdc, V _{CE} = -5.0 Vdc)		V _{BE(on)}	-	-1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product $(I_C = -250 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc}, f = 20 \text{ MHz})$		fT	50	-	MHz
Output Capacitance (V _{CB} = -10 Vdc, f = 1.0 MHz)		C _{obo}		15	pF

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 - D.C. CURRENT GAIN

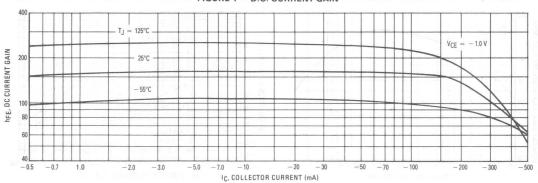


FIGURE 2 — COLLECTOR SATURATION REGION

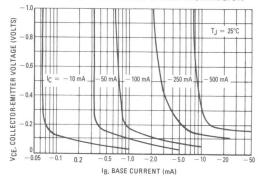


FIGURE 3 — ON VOLTAGES

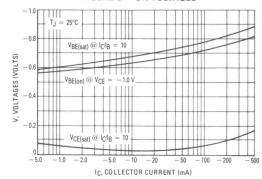


FIGURE 4 - BASE-EMITTER

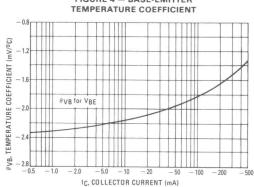
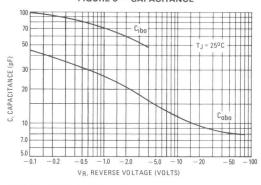
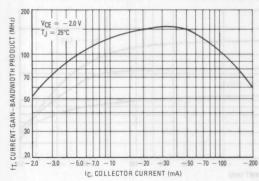


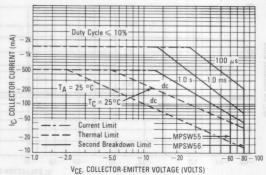
FIGURE 5 — CAPACITANCE

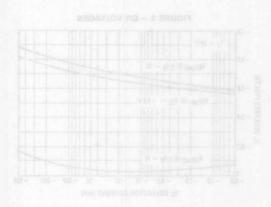


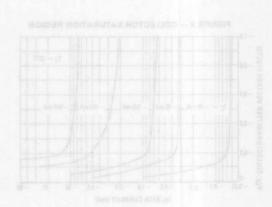
MPSW55 MPSW56

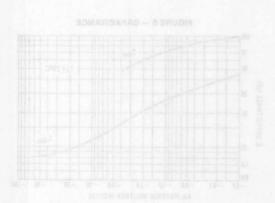


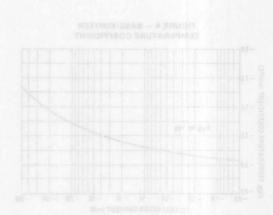












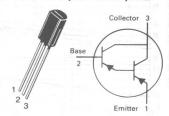
Rating	Symbol	MPSW63 MPSW64	Unit
Collector-Emitter Voltage	VCES	-30	Vdc
Collector-Base Voltage	V _{CBO}	-30	Vdc
Emitter-Base Voltage	VEBO	-10	Vdc
Collector Current — Continuous	Ic	-500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

MPSW63 MPSW64*

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



ONE WATT DARLINGTON TRANSISTORS

PNP SILICON

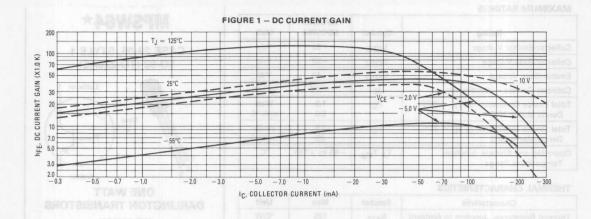
★This is a Motorola designated preferred device.

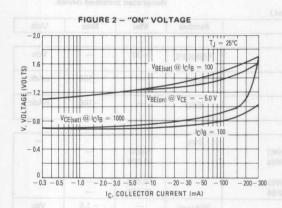
ELECTRICAL CHARACTERISTICS T_A = 25°C unless otherwise noted.)

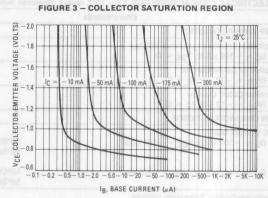
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS		10	10111		
Collector-Emitter Breakdown Voltage (I _C = -100 µAdc, V _{BE} = 0)		V(BR)CES	-30	-	Vdc
Collector Cutoff Current (V _{CB} = -30 Vdc, I _E = 0)		ІСВО	-	-100	nAdc
Emitter Cutoff Current (V _{EB} = -10 Vdc, I _C = 0)		I _{EBO}	14) r = 1	-100	nAdc
ON CHARACTERISTICS(1)					80-
DC Current Gain ($I_C = -10$ mAdc, $V_{CE} = -5.0$ Vdc)	MPSW63 MPSW64	hFE	5,000 10,000	=	2
$(I_C = -100 \text{ mAdc}, V_{CE} = -5.0 \text{ Vdc})$	MPSW63 MPSW64		10,000 20,000	_	T. T.
Collector-Emitter Saturation Voltage ($I_C = -100 \text{ mAdc}$, $I_B = -0.1 \text{ mAdc}$)		V _{CE(sat)}	_	- 1.5	Vdc
Base-Emitter On Voltage ($I_C = -100 \text{ mAdc}$, $V_{CE} = -5.0 \text{ Vdc}$)		V _{BE} (on)	_	-2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I _C = -10 mAdc, V _{CE} = -5.0 Vdc, f = 100 MHz)		fT	125		MHz

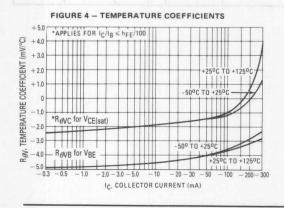
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

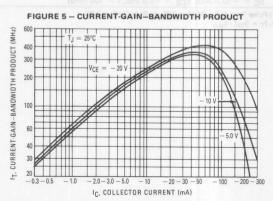
⁽²⁾ $f_T = |h_{fe}| \cdot f_{test}$.



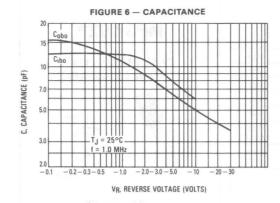


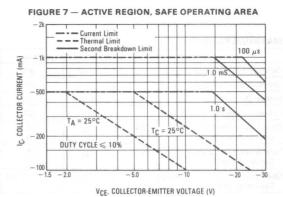






MPSW63 MPSW64





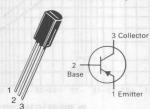
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-300	Vdc
Collector-Base Voltage	VCBO	-300	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current — Continuous	IC	-500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

MPSW92*

CASE 29-05, STYLE 1 TO-92 (TO-226AE)



ONE WATT HIGH VOLTAGE TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I _C = -1.0 mAdc, I _B = 0)	V(BR)CEO	-300	_	Vdc
Collector-Base Breakdown Voltage ($I_C = -100 \mu Adc, I_E = 0$)	V(BR)CBO	-300	-	Vdc
Emitter-Base Breakdown Voltage ($I_E = -100 \mu Adc, I_C = 0$)	V(BR)EBO	-5.0	_	Vdc
Collector Cutoff Current (V _{CB} = -200 Vdc, I _E = 0)	ІСВО		-0.25	μAdc
Emitter Cutoff Current (V _{EB} = -3.0 Vdc, I _C = 0)	IEBO	-	-0.1	μAdc
ON CHARACTERISTICS(1)				
DC Current Gain	hFE	25 40 25	=	-
Collector-Emitter Saturation Voltage ($I_C = -20 \text{ mAdc}$, $I_B = -2.0 \text{ mAdc}$)	VCE(sat)		-0.5	Vdc
Base-Emitter Saturation Voltage $(I_C = -20 \text{ mAdc}, I_B = -2.0 \text{ mAdc})$	V _{BE(sat)}	-	-0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = -10 \text{ mAdc}$, $V_{CE} = -20 \text{ Vdc}$, $f = 20 \text{ MHz}$)	f _T	50	-	MHz
Collector-Base Capacitance ($V_{CB} = -20 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C _{cb}		6.0	pF

(1) Pulse Test: Pulse Width \leqslant 300 μ s, Duty Cycle \leqslant 2.0%.

FIGURE 1 - D.C. CURRENT GAIN

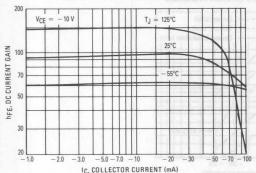


FIGURE 2 — COLLECTOR SATURATION REGION

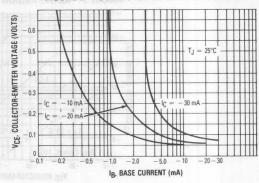


FIGURE 3 - ON VOLTAGES

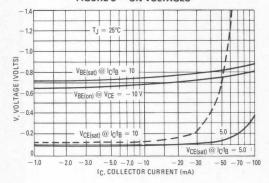


FIGURE 4 - TEMPERATURE COEFFICIENTS

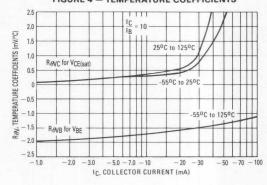


FIGURE 5 - CAPACITANCE

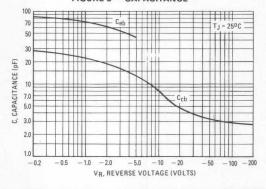
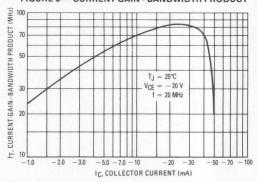
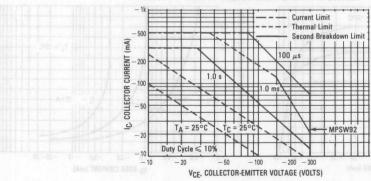
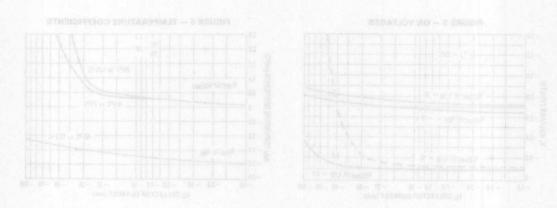


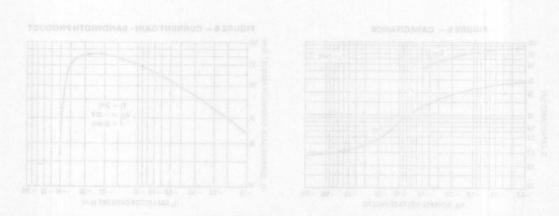
FIGURE 6 — CURRENT GAIN - BANDWIDTH PRODUCT











MSB709-RT1*

MAXIMUM RATINGS (TA = 25°C)

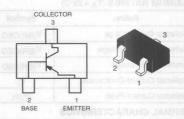
in brillian in the transfer (A = 0 0)			
Rating	Symbol	Value	Unit
Collector-Base Voltage	V _{CBO}	-30	V
Collector-Emitter Voltage	VCEO	-20	V
Emitter-Base Voltage	VEBO	-5	V
Collector Current-Continuous	Ic	-30	mA

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	APILIPINAT _J	150	°C
Storage Temperature	T _{stg}	-55 ~ + 150	°C

MSA1022-BT1* MSA1022-CT1*

CASE 318D-03, STYLE 1



SC-59 PACKAGE PNP RF AMPLIFIER TRANSISTORS SURFACE MOUNT

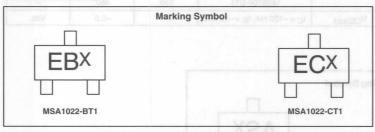
*These are Motorola designated preferred devices.

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic	Symbol	Condition	Min	Max	Unit
Collector Cutoff Current	I _{CBO}	$V_{CB} = -10 \text{ V}, I_{E} = 0$	/ -	- 0.1	μА
Collector-Emitter Breakdown Voltage	ICEO	V _{CE} = -20 V, I _B = 0		-100	μА
Emitter-Base Breakdown Voltage	IEBO	V _{EB} = -5 V, I _C = 0	_	-10	μА
DC Current Gain	h _{FE*} = 31 A	V _{CE} = -10 V, I _C = -1 mA MSA1022-BT1 MSA1022-CT1	70 110	140 220	ner-Base deform Voltage
Current-Gain — Bandwidth Product	fT	V _{CB} = -10 V, I _E = 1 mA	150		MHz

^{*}Pulse Test: Pulse Width ≤ 300 μs, D.C. ≤ 2%.

DEVICE MARKING



The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

MSA1022-BT1* MSA1022-CT1*

MAXIMUM RATINGS (T_A = 25°C)

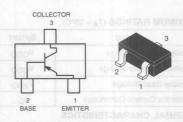
Rating	Symbol	Value	Unit
Collector-Base Voltage	V _(BR) CBO	-25	Vdc
Collector-Emitter Voltage	V(BR)CEO	-25	Vdc
Emitter-Base Voltage	V(BR)EBO	-7	Vdc
Collector Current-Continuous	lc	-100	mAdc
Collector Current-Peak	IC(P)	-200	mAdc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	TJ	150	°C
Storage Temperature Range	T _{stg}	-55 ~ + 150	03°C - 88

MSB709-RT1* MSB709-ST1

CASE 318D-03, STYLE 1



SC-59 PACKAGE
PNP GENERAL PURPOSE
AMPLIFIER TRANSISTORS
SURFACE MOUNT

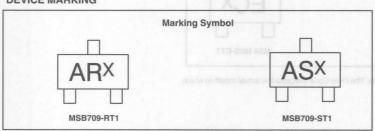
*This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic	Symbol	Condition Condition	Min	Max	Unit
Collector-Emitter Breakdown Voltage	V(BR)CEO	$I_C = -2.0 \text{ mA}, I_B = 0$	-25	= monu	Vdc 100
Collector-Base Breakdown Voltage	V(BR)CBO	I _C = -10 μA, I _E = 0	-25	egatloV nwo Na	Vdc
Emitter-Base Breakdown Voltage	V _{(BR)EBO}	$I_E = -10 \mu\text{A}, I_E = 0$	-7		Vdc
Collector-Base Cutoff Current	Ісво	V _{CB} = -20 V, I _E = 0		-0.1	μА
Collector-Emitter Cutoff Current	ICEO	$V_{CE} = -10 \text{ V}, I_B = 0$		-100	μА
DC Current Gain	hFE1*	V _{CE} = -10 V, I _C = -2.0 mA MSB709-RT1 MSB709-ST1	210 290	340 460	EVICE MAR
Collector-Emitter Saturation Voltage	VCE(sat)	I _C = -100 mA, I _B = -10 mA	Narking 6	-0.5	Vdc

^{*}Pulse Test: Pulse Width \leq 300 $\mu s,\, D.C. \leq$ 2%.

DEVICE MARKING



The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

MAXIMUM RATINGS (T_A = 25°C)

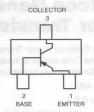
Rating	Symbol	Value	Unit
Collector-Base Voltage	V _(BR) CBO	-30	Vdc
Collector-Emitter Voltage	V(BR)CEO	-25	Vdc
Emitter-Base Voltage	V(BR)EBO	-7	Vdc
Collector Current-Continuous	IC	-500	mAdc
Collector Current-Peak	IC(P)	-1	Adc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	TJ	150	°C
Storage Temperature Range	T _{sta}	-55 ~ + 150	°C

MSB710-QT1 MSB710-RT1*

CASE 318D-03, STYLE 1





SC-59 PACKAGE PNP GENERAL PURPOSE AMPLIFIER TRANSISTORS SURFACE MOUNT

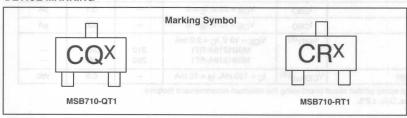
*This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic	Symbol	Condition	Min	Max	Unit
Collector-Emitter Breakdown Voltage	V(BR)CEO	$I_C = -10 \text{ mA}, I_B = 0$	-25	uning— Incula	Vdc
Collector-Base Breakdown Voltage	V(BR)CBO	$I_C = -10 \mu\text{A}, I_E = 0$	-30	DMDX3/	Vdc
Emitter-Base Breakdown Voltage	V(BR)EBO	$I_E = -10 \mu\text{A}, I_C = 0$	-7	F S = 1T9- 881 = F13-	Vdc
Collector-Base Cutoff Current	Ісво	V _{CB} = -20 V, I _E = 0	- волга	-0.1	μΑ
DC Current Gain	Win 0	V _{CE} = -10 V, I _C = -150 mA MSB710-QT1 MSB710-RT1	85 120	170 240	Power Unit
	hFE2*	V _{CE} = -10 V, I _C = 500 mA	40	.s—imeom	T notion—
Collector-Emitter Saturation Voltage	VCE(sat)	I _C = -300 mA, I _B = -30 mA	_	-0.6	Vdc
Collector-Base Saturation Voltage	V _{BE(sat)}	IC = -300 mA, IB = -30 mA	ADJUGBE AND A STATE OF THE STAT	-1.5	Vdc
Output Capacitance	C _{ob}	V _{CB} = -10 V, I _E = 0, f = 1.0 MHz	dintic	15	pF

*Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

DEVICE MARKING



The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

PNP Silicon General Purpose Amplifier Transistor

This PNP Silicon Epitaxial Planar Transistor is designed for general purpose amplifier applications. This device is housed in the SC-70/SOT-323 package which is designed for low power surface mount applications.

- High hFE, 210-460
- Low VCE(sat), < 0.5 V
- · Available in 8 mm, 7-inch/3000 Unit Tape and Reel

MAXIMUM RATINGS (TA = 25°C)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V(BR)CBO	45	Vdc
Collector-Emitter Voltage	V(BR)CEO	45	Vdc
Emitter-Base Voltage	V(BR)EBO	7.0	Vdc
Collector Current — Continuous	o - al Alcar-	100	mAdc
Collector Current — Peak	IC(P)	200	mAdc

DEVICE MARKING

MSB1218A-RT1 = BR MSB1218A-ST1 = BS

THERMAL CHARACTERISTICS

Rating		Symbol	Max	Unit
Power Dissipation		P _D (1)	150	mW
Junction Temperature	Ani Ot	- TJ	150	°C
Storage Temperature Range	Am DE	T _{stg}	-55 ~ +150	o°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Condition	Min	Max	Unit
Collector-Emitter Breakdown Voltage	V(BR)CEO	$I_C = 2.0 \text{ mA}, I_B = 0$	45	Season S	Vdc
Collector-Base Breakdown Voltage	V(BR)CBO	I _C = 10 μA, I _E = 0	45	-	Vdc
Emitter-Base Breakdown Voltage	V _{(BR)EBO}	I _E = 10 μA, I _E = 0	7.0	KING	Vdc
Collector-Base Cutoff Current	ICBO	V _{CB} = 20 V, I _E = 0	_	0.1	μА
Collector-Emitter Cutoff Current	ICEO	V _{CE} = 10 V, I _B = 0		100	μА
DC Current Gain	h _{FE1} (2)	V _{CE} = 10 V, I _C = 2.0 mA MSB1218A-RT1 MSB1218A-ST1	210 290	340 460]=
Collector-Emitter Saturation Voltage	V _{CE(sat)} (2)	I _C = 100 mA, I _B = 10 mA	- 7	0.5	Vdc

(1) Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.

(2) Pulse Test: Pulse Width \leq 300 μ s, D.C. \leq 2%.

Preferred devices are Motorola recommended choices for future use and best overall value.

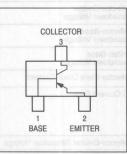
MSB1218A-RT1 MSB1218A-ST1

Motorola Preferred Devices

PNP GENERAL
PURPOSE AMPLIFIER
TRANSISTORS
SURFACE MOUNT



CASE 419-02, STYLE 3 SC-70/SOT-323



MSB1218A-RT1 MSB1218A-ST1

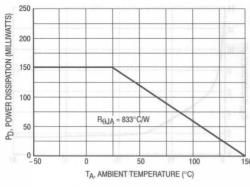


Figure 1. Derating Curve

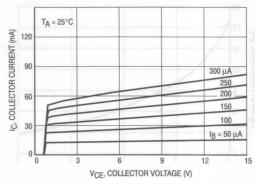


Figure 2. Ic - VCE

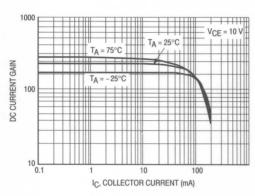


Figure 3. DC Current Gain

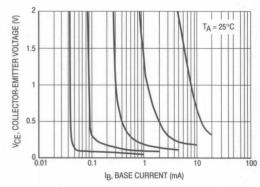


Figure 4. Collector Saturation Region

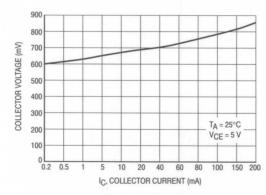


Figure 5. On Voltage

MSB1218A-RT1 MSB1218A-ST1

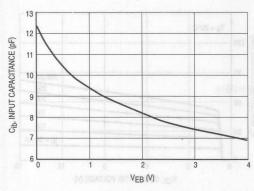


Figure 6. Capacitance

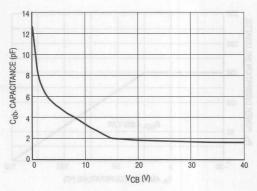
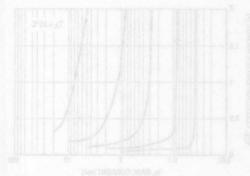
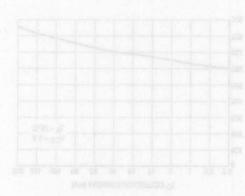


Figure 7. Capacitance





iquio 3, DD Current Galn -



2-418

MSC2295-BT1 * MSC2295-CT1 * CASE 318D-03, STYLE 1

MAXIMUM RATINGS (TA = 25°C)

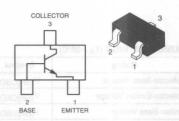
Rating	Symbol	Value	Unit
Collector-Base Voltage	VCBO	40	V
Collector-Emitter Voltage	VCEO	20	V
Emitter-Base Voltage	VEBO	5	V
Collector Current-Continuous	IC.	200	mA

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	TJ	150	°C
Storage Temperature Range	T _{stg}	-55 ~ + 150	°C

MSC1621T1*

CASE 318D-03, STYLE 1



SC-59 PACKAGE NPN SWITCHING TRANSISTOR SURFACE MOUNT

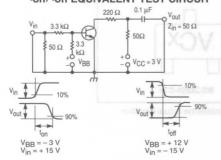
*This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (TA = 25°C)

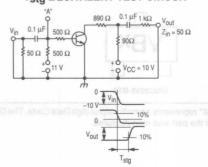
Characteristic Section 1	Symbol	Condition	Min	Max	Unit
Collector Cutoff Current	ICBO	V _{CB} = 30 V, I _E = 0	ice (T_earch	0.1 AF AF	μΑ
Emitter Base Cutoff Current	I _{EBO}	V _{EB} = 4.0 V, I _C = 0	-	0.1	μА
DC Current Gain	hFE* 0 = 31	V _{CE} = 0.5 V, I _C = 1 mA	40	180	ollect Base
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C = 10 mA, I _B = 1.0 mA	-	0.25	V C
Base-Emitter Saturation Voltage	V _{BE(sat)}	I _C = 10 mA, I _B = 1.0 mA	I -	0.85	٧
Current-Gain — Bandwidth Product	fT	V _{CE} = 10 V, I _E = -10 mA	200	_	MHz
Output Capacitance	C _{ob}	V _{CB} = 10 V, I _E = 0, f = 1.0 MHz	_ 101	6.0	elanmT earovs
Turn On Time	ton	T,01 61	_	20	ns
Storage Temperature Range	T _{stg}	I _C = 10 mA in Equivalent Test Circuit	_	20	ns
Turn Off Time	toff		_	40	ns

^{*}Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

ton, toff EQUIVALENT TEST CIRCUIT



T_{stg} EQUIVALENT TEST CIRCUIT



Marking Symbol



DEVICE MARKING

The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

MAXIMUM RATINGS (TA = 25°C)

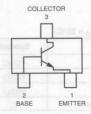
Rating	Symbol	Value	Unit
Collector-Base Voltage	V(BR)CBO	30	Vdc
Collector-Emitter Voltage	V(BR)CEO	20	Vdc
Emitter-Base Voltage	V(BR)EBO	5	Vdc
Collector Current-Continuous	IC.	30	mAdc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	TJ	150	°C
Storage Temperature	T _{stg}	-55 ~ + 150	°C

MSC2295-BT1* MSC2295-CT1*

CASE 318D-03, STYLE 1





SC-59 PACKAGE NPN RF AMPLIFIER TRANSISTORS SURFACE MOUNT

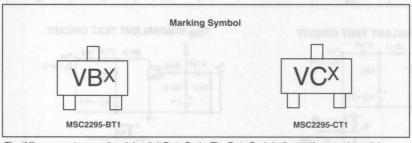
*These are Motorola designated preferred devices.

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic	Symbol	Condition	Min	Max	Unit
Collector-Base Cutoff Current	ІСВО	V _{CB} = 10 V, I _E = 0		0.1	μА
DC Current Gain	hFE*	V _{CB} = 10 V, I _E = -1 mA MSC2295-BT1 MSC2295-CT1	70 110	140 220	Collector-Empto Saxo-E m itter Sc Sursen -C oun
Collector-Gain — Bandwidth Product	fT	V _{CB} = 10 V, I _E = -1 mA	150	- 100	MHz
Reverse Transistor Capacitance	C _{re}	V _{CE} = 10 V, I _C = 1 mA, f = 10.7 MHz		1.5	pF

^{*}Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

DEVICE MARKING



 $\label{thm:code} The \ "X" \ represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.$

MSC3130T1

CASE 318D-03, STYLE 1

MAXIMUM RATINGS (TA = 25°C)

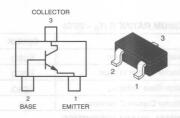
Rating	Symbol	Value	Unit
Collector-Base Voltage	V(BR)CBO	30	Vdc
Collector-Emitter Voltage	V(BR)CEO	20 🗸	Vdc
Emitter-Base Voltage	V(BR)EBO	3	Vdc
Collector Current-Continuous	Ic	15	mAdc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	150	mW
Junction Temperature	TJ	150	°C
Storage Temperature Range	T _{stg}	-55 ~ + 150	°C

MSC2404-CT1*

CASE 318D-03, STYLE 1



SC-59 PACKAGE NPN RF AMPLIFIER TRANSISTOR SURFACE MOUNT

*This is a Motorola designated preferred device.

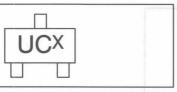
ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Symbol	Condition	Min	Max	Unit
Collector-Base Breakdown Voltage	V(BR)CBO	I _C = 10 μA, I _E = 0	30	- Into y	Vdc
Collector Emitter Breakdown Voltage	V(BR)EBO	I _E = 10 μA, I _C = 0	3	egisdby mybbano s	Vdc
DC Current Gain	hFE*	V _{CB} = 6 V, I _E = -1 mA	65	160	nii eas d ist
Current-Gain — Bandwidth Product	fT Am a	V _{CB} = 6 V, I _E = -1 mA	450	<u> </u>	MHz
Reverse Transfer Capacitance	C _{re}	V _{CE} = 6 V, I _C = 1 mA, f = 10.7 MHz	v +	ageAoV of lands	pF

^{*}Pulse Test: Pulse Width \leq 300 $\mu s,\, D.C. \leq$ 2%.

DEVICE MARKING

Marking Symbol



The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

MAXIMUM RATINGS (TA = 25°C)

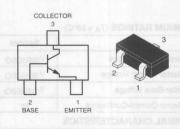
Rating	Symbol	Value	Unit
Collector-Base Voltage	V _{CBO}	15	V
Collector-Emitter Voltage	VCEO	10	V
Emitter-Base Voltage	V _{EBO}	3	V
Collector Current-Continuous	Ic	50	mA

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	TJ	150	°C
Storage Temperature Range	T _{stg}	-55 ~ + 150	°C

MSC3130T1*

CASE 318D-03, STYLE 1



SC-59 PACKAGE NPN RF AMPLIFIER TRANSISTOR SURFACE MOUNT

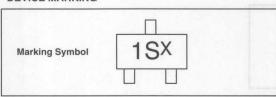
*This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic	Symbol	Condition	Min	Max	Unit
Collector Cutoff Current	Ісво	V _{CB} = 10 V, I _E = 0	W +	epsilo/mwotas	μА
Collector-Emitter Breakdown Voltage	VCEO	I _C = 2 mA, I _B = 0	10	ea),dawn Voltage	V
Emitter-Base Breakdown Voltage	VEBO	I _E = 10 μA, I _C = 0	3	-	mas V us
DC Current Gain	h _{FE*}	V _{CE} = 4 V, I _C = 5 mA	75	400	ant (<u>s</u> ain Ba
Collector-Emitter Saturation Voltage	V _{CE(sat)}	I _C = 20 mA, I _B = 4 mA	-	0.5	V
Current-Gain — Bandwidth Product	fT	V _{CB} = 4 V, I _E = -5 mA	1.4	2.5	GHz

^{*}Pulse Test: Pulse Width ≤ 300 μs, D.C. ≤ 2%.

DEVICE MARKING



The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

MAXIMUM RATINGS (TA = 25°C)

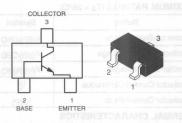
Rating	Symbol	Value	Unit
Collector-Base Voltage	V(BR)CBO	30	Vdc
Collector-Emitter Voltage	V(BR)CEO	25	Vdc
Emitter-Base Voltage	V _{(BR)EBO}	7 04	Vdc
Collector Current-Continuous	IC	100	mAdc
Collector Current-Peak	IC(P)	200	mAdc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	TJ	150	°C
Storage Temperature	T _{stg}	-55 ~ + 150	°C

MSD601-RT1* MSD601-ST1

CASE 318D-03, STYLE 1



SC-59 PACKAGE NPN GENERAL PURPOSE AMPLIFIER TRANSISTORS SURFACE MOUNT

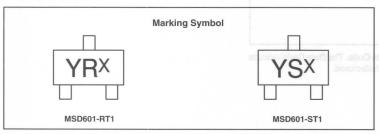
*This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic	6000	Symbol	Condition	Min	Max	Unit
Collector-Emitter Breakdown Voltage	ás.	V(BR)CEO	I _C = 2.0 mA, I _B = 0	25	Briskd ol m Voltage	Vdc
Collector-Base Breakdown Voltage	7	V _(BR) CBO	I _C = 10 μA, I _E = 0	30	apatioV nwolula	Vdc
Emitter-Base Breakdown Voltage		V _{(BR)EBO}	I _E = 10 μA, I _C = 0	7	IncircuO 7 otu	Vdc
Collector-Base Cutoff Current	1007	ІСВО	V _{CB} = 20 V, I _E = 0		0.1	μА
Collector-Emitter Cutoff Current		ICEO	V _{CE} = 10 V, I _B = 0		100	μА
DC Current Gain		hFE1*	V _{CE} = 10 V, I _C = 2.0 mA MSD601-RT1	210	340	put Capacilai
			MSD601-ST1	290	460	rits/W est ati dest
		h _{FE2*}	V _{CE} = 2.0 V, I _C = 100 mA	90	_	_
Collector-Emitter Saturation Voltage		V _{CE(sat)}	I _C = 100 mA, I _B = 10 mA	_	0.5	Vdc

^{*}Pulse Test: Pulse Width \leq 300 $\mu\text{s}, \text{ D.C.} \leq$ 2%.

DEVICE MARKING



The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

MSD601-ST1

MAXIMUM RATINGS (TA = 25°C)

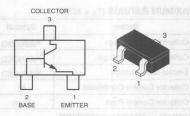
Rating	Symbol	Value	Unit
Collector-Base Voltage	V(BR)CBO	30	Vdc
Collector-Emitter Voltage	V(BR)CEO	25	Vdc
Emitter-Base Voltage	VE(BR)BO	7,,,,	Vdc
Collector Current-Continuous	IC	500	mAdc
Collector Current-Peak	IC(P)	1stern	Adc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	TJ	150	°C
Storage Temperature Range	T _{stg}	-55 ~ + 150	0.°C

MSD602-RT1*

CASE 318D-03, STYLE 1



SC-59 PACKAGE NPN GENERAL PURPOSE AMPLIFIER TRANSISTOR SURFACE MOUNT

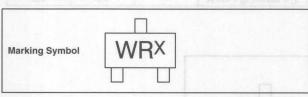
*This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic	Symbol	Condition Condition	Min	Max	Unit
Collector-Emitter Breakdown Voltage	V(BR)CEO	I _C = 10 mA, I _B = 0	25	-	Vdc
Collector-Base Breakdown Voltage	V(BR)CBO	I _C = 10 μA, I _E = 0	30		Vdc
Emitter-Base Breakdown Voltage	V(BR)EBO	I _E = 10 μA, I _C = 0	7	- 4	Vdc
Collector-Base Cutoff Current	ICBO 0 = of	V _{CB} = 20 V, I _E = 0	_	0.1	μА
DC Current Gain	hFE1*	V _{CE} = 10 V, I _C = 150 mA	120	240	A shired water
	hFE2*	V _{CE} = 10 V, I _C = 500 mA	40		
Collector-Emitter Saturation Voltage	VCE(sat)	I _C = 300 mA, I _B = 30 mA		0.6	Vdc
Output Capacitance	Cob	V _{CB} = 10 V, I _E = 0, f = 1 MHz		15	pF

^{*}Pulse Test: Pulse Width \leq 300 $\mu\text{s}, \text{ D.C.} \leq$ 2%.

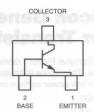
DEVICE MARKING

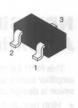


The "X" represents a smaller alpha digit Date Code. The Date Code indicate the actual month in which the part was manufactured.

MSD1328-RT1*

CASE 318D-03, STYLE 1





SC-59 PACKAGE NPN LOW VOLTAGE OUTPUT AMPLIFIER SURFACE MOUNT

*This is a Motorola designated preferred device.

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V _(BR) CBO	25	Vdc
Collector-Emitter Voltage	V(BR)CEO	20	Vdc
Emitter-Base Voltage	V _E (BR)BO	12 9 63	Vdc
Collector Current-Continuous	Ic	500	mAdc
Collector Current-Peak	IC(P)	1000	mAdc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	TJ	150	°C
Storage Temperature Range	T _{stg}	-55 ~ + 150	°C

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic	Symbol	Condition	Min	Max	Unit
Collector-Emitter Breakdown Voltage	V(BR)CEO	I _C = 1.0 mA, I _B = 0	20	N 10110 100 - 11 31 1	Vdc
Collector-Base Breakdown Voltage	V _(BR) CBO	I _C = 10 μA, I _E = 0	25	7120-1 - 11 31 1	Vdc
Emitter-Base Breakdown Voltage	V(BR)EBO	I _E = 10 μA, I _E = 0	12	- 100 a 200	Vdc
Collector-Base Cutoff Current	Ісво	V _{CB} = 25 V, I _E = 0	_	0.1	μА
DC Current Gain	h _{FE*}	V _{CE} = 2 V, I _C = 500 mA	200	350	JAMPER
Collector-Emitter Saturation Voltage	VCE(sat)	I _C = 500 mA, I _B = 20 mA		0.4	Vdc
Base–Emitter Saturation Voltage	V _{BE(sat)}	I _C = 500 mA, I _B = 50 mA	_	1.2	Vdc

^{*}Pulse Test: Pulse Width \leq 300 μ s, D.C. \leq 2%.

DEVICE MARKING

Marking Symbol

The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

NPN Silicon General Purpose Amplifier Transistor

This NPN Silicon Epitaxial Planar Transistor is designed for general purpose amplifier applications. This device is housed in the SC-70/SOT-323 package which is designed for low power surface mount applications.

- High hfe, 210-460
- Low VCE(sat), < 0.5 V
- · Available in 8 mm, 7-inch/3000 Unit Tape and Reel

MAXIMUM RATINGS (TA = 25°C)

Rating	Symbol	Value	Unit Vdc	
Collector-Base Voltage	V _(BR) CBO	60		
Collector-Emitter Voltage	V(BR)CEO	50	Vdc	
Emitter-Base Voltage	V(BR)EBO	7.0	Vdc	
Collector Current — Continuous	IC	100	mAdd	
Collector Current — Peak	IC(P)	200	mAdd	

DEVICE MARKING

MSD1819A-RT1 = ZR MSD1819A-ST1 = ZS

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	P _D (1)	150	mW
Junction Temperature	TJ	150	°C
Storage Temperature Range	T _{stg}	-55 ~ +150	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Condition	Min	Max	Unit
Collector-Emitter Breakdown Voltage	V(BR)CEO	I _C = 2.0 mA, I _B = 0	50	-	Vdc
Collector-Base Breakdown Voltage	V(BR)CBO	I _C = 10 μA, I _E = 0	60	_	Vdc
Emitter-Base Breakdown Voltage	V _{(BR)EBO}	I _E = 10 μA, I _E = 0	7.0	-	Vdc
Collector-Base Cutoff Current	Ісво	V _{CB} = 20 V, I _E = 0	-	0.1	μА
Collector-Emitter Cutoff Current	ICEO	V _{CE} = 10 V, I _B = 0	T-	100	μА
DC Current Gain	h _{FE1} (2)	V _{CE} = 10 V, I _C = 2.0 mA MSD1819A-RT1 MSD1819A-ST1	210 290	340 460	erge <u>r</u> "
	h _{FE2} (2)	V _{CE} = 2.0 V, I _C = 100 mA	90	-	-
Collector-Emitter Saturation Voltage	V _{CE(sat)} (2)	I _C = 100 mA, I _B = 10 mA	-	0.5	Vdc

(1) Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.

(2) Pulse Test: Pulse Width ≤ 300 μs, D.C. ≤ 2%.

Preferred devices are Motorola recommended choices for future use and best overall value.

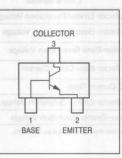
MSD1819A-RT1 MSD1819A-ST1

Motorola Preferred Devices

NPN GENERAL
PURPOSE AMPLIFIER
TRANSISTORS
SURFACE MOUNT



CASE 419-02, STYLE 3 SC-70/SOT-323



MSD1819A-RT1 MSD1819A-ST1

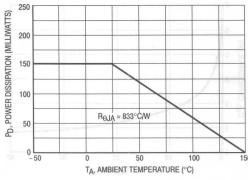


Figure 1. Derating Curve

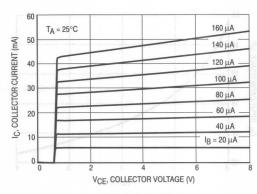


Figure 2. IC - VCE

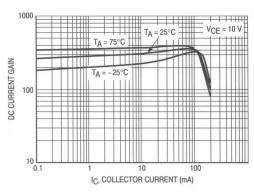


Figure 3. DC Current Gain

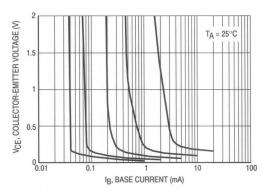


Figure 4. Collector Saturation Region

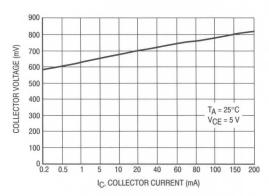


Figure 5. On Voltage

MSD1819A-RT1 MSD1819A-ST1

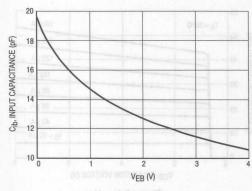


Figure 6. Capacitance

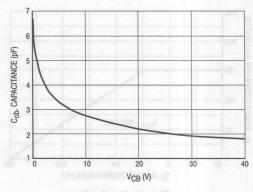
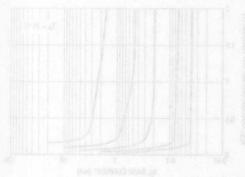


Figure 7. Capacitance



Name of the State of the State of State



Figure 3. DC Current Gain

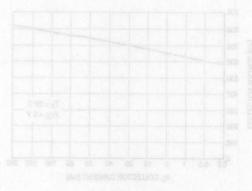


Figure 5. On Voltage

MUNICIPAL STREET

Bias Resistor Transistor

PNP Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

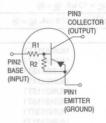
This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base-emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC-59 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- The SC-59 package can be soldered using wave or reflow.
 The modified gull-winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
 Use the Device Number to order the 7 inch/3000 unit reel.

MUN2111T1 SERIES

Motorola Preferred Devices

PNP SILICON BIAS RESISTOR TRANSISTOR





CASE 318D-03, STYLE 1 (SC-59)

MAXIMUM RATINGS (TA = 25°C unless otherwise noted)

Rating	Symbo	l Value	Unit
Collector-Base Voltage	VCBO	50 000	Vdc
Collector-Emitter Voltage	VCEO	Treasing (Am a	Vdc =
Collector Current	IC	100	mAdc
Total Power Dissipation @ T _A = 25°C(1) Derate above 25°C	JOV PD	200 1.6	mW mW/°C

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)	R ₀ JA	625	°C/W
Operating and Storage Temperature Range	T _J , T _{stg}	-65 to +150	°C
Maximum Temperature for Soldering Purposes, Time in Solder Bath	TTOETSTELM MUNICIPALTS	260 10	°C Sec

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	R2 (K)
MUN2111T1	6A	10	10
MUN2112T1	6B	22 3 3 5 5 5 7 6 7 7 7	au 006 > nto W 22 19 380T 88119
MUN2113T1	6C	47	47
MUN2114T1	6D	10	47
MUN2115T1(2)	6E	10	00
MUN2116T1(2)	6F	4.7	00
MUN2130T1(2)	6G	1.0	1.0
MUN2131T1(2)	6H	2.2	2.2
MUN2132T1(2)	6J	4.7	4.7
MUN2133T1(2)	6K	4.7	47
MUN2134T1 ⁽²⁾	6L	22	47

- 1. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.
- 2. New devices. Updated curves to follow in subsequent data sheets.

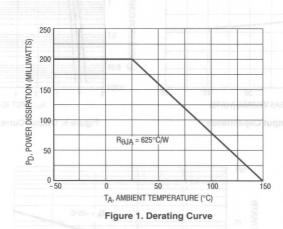
Preferred devices are Motorola recommended choices for future use and best overall value.

	Characteristic		Symbol	Min	Тур	Max	Unit
FF CHARACTERIST	ics			6	and the same of		
Collector-Base Cutoff	f Current (V _{CB} = 50 V,	IE = 0)	Ісво	e land	11 70	100	nAdc
Collector-Emitter Cut	off Current (V _{CE} = 50	V, I _B = 0)	ICEO	eti-/mu	SCP MC	500	nAdc
Emitter-Base Cutoff C	Current	MUN2111T1	IEBO	wiell r	Redsto	0.5	mAdc
$(V_{EB} = 6.0 \text{ V, I}_{C} =$	0)	MUN2112T1		_	_	0.2	
		MUN2113T1	lia s exsteat of	treng le ab a	esote ie nm) l	0.1	is now so
		MUN2114T1	Blas Resistor	THE-BIT	sas n et work	0.2	menxe ati
		MUN2115T1	eienco-Jhowten	enid Tritio	iom a 188w 1	0.9	nia a onia
		MUN2116T1	DRP edif notate	SO-OUTSILES DE	ed a billis note	1.9	se s. wol.
		MUN2130T1	nout stook s.d	ini madi ndi	school vid se	4.3	e trabilitati a
		MUN2131T1	noon Tino Acriros	as based ba	a Forma mentau	2.3	nes THE
		MUN2132T1	POUR DO SERVE AND AND	al vel lucas	hich is des	1.5	03 03
		MUN2133T1	mine many w	ni ini notifi	aeb <u>ar</u> dold	0.18	nunlinal
		MUN2134T1				0.13	BURULES
Collector-Base Breakdown Voltage ($I_C = 10 \mu A, I_E = 0$)		V _(BR) CBO	50	-	FEISECT THEM	Vdc	
Collector-Emitter Breakdown Voltage(3) (I _C = 2.0 mA, I _B = 0)		V(BR)CEO	50	-	REMUG LAISE	Vdc	
N CHARACTERISTIC	CS(3)				THE STATE OF THE S	A THE TOTAL	AN ANALYSIS
DC Current Gain		MUN2111T1	hFE	35	60	bereing I in h	A TIME OF THE
(VCE = 10 V, IC =	5.0 mA)	MUN2112T1	elb ent	60	100		a salashie
		MUN2113T1	Tigin eth	80	140	an firms day	Sixianin
		MUN2114T1		80	140	8 may ambd	n eldeliev
		MUN2115T1	lean fine	160	250	edme# ably	se the Do
		MUN2116T1		160	250	-	
		MUN2130T1		3.0	5.0	_	
		MUN2131T1		8.0	15	_	1000
		MUN2132T1	(0)	15	27	(AT) 2001/17	H MUMB
		MUN2133T1		80	140	_	
		MUN2134T1		80	130		
$(I_C = 10 \text{ mA}, I_B =$	uration Voltage (I _C = 1 5 mA) MUN2131T1 1 mA) MUN2116T1/MI MUN2134T1	osoV Voso	VCE(sat)	_	TO SERVE	0.25	Vdc
Output Voltage (on)			VOL		1000	Child In	Vdc
$(V_{CC} = 5.0 \text{ V}, V_{B})$	= 2.5 V , $R_L = 1.0 \text{ k}\Omega$)	MUN2111T1				0.2	
		MUN2112T1			20118	0.2	U JAMPI
		MUN2114T1	(betrue	on enthus) t	den-to-Ambie	0.2	scoff Immre
		MUN2115T1			om Cl early	0.2	and the state of
		MUN2116T1			graft <u>ine</u> Rang	0.2	and the latest the lat
		MUN2130T1		- ,368	ordan ing Purp	0.2	to Emumix
		MUN2131T1				0.2	ne in Solds
		MUN2132T1		230116	ROTEISSI	0.2	HOE MAD
		MUN2133T1			_	0.2	
(Vac - 5 0 V V-	- 2 E V Pr - 1 0 kOV	MUN2134T1		S-01/2W		0.2	H. Carlotte
(VCC = 5.0 V, VB	= 3.5 V , $R_L = 1.0 \text{ k}\Omega$)	MUN2113T1				0.2	The same of the same

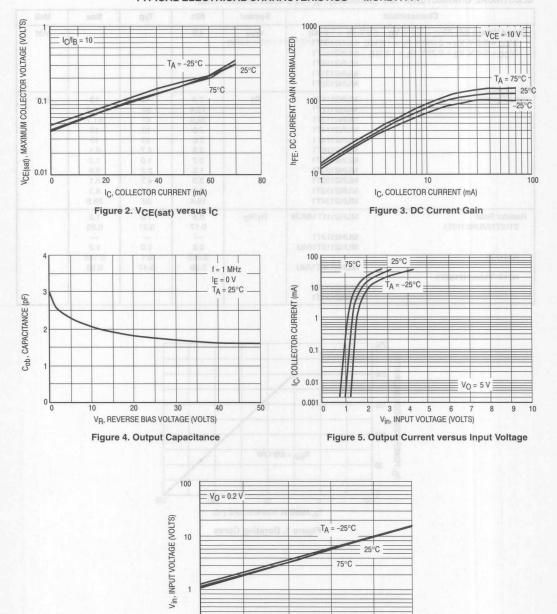
^{3.} Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (Continued) (T_A = 25°C unless otherwise noted)

		Symbol	Min	Тур	Max	Unit
		Voн	4.9		01 - 86	Vdc
Input Resistor	MUN2111T1 MUN2112T1 MUN2113T1 MUN2114T1 MUN2115T1 MUN2116T1 MUN2130T1 MUN2131T1 MUN2132T1 MUN2133T1 MUN2133T1 MUN2133T1 MUN2134T1	R1	7.0 15.4 32.9 7.0 7.0 3.3 0.7 1.5 3.3 3.3 15.4	10 22 47 10 10 4.7 1.0 2.2 4.7 4.7 22	13 28.6 61.1 13 13 6.1 1.3 2.9 6.1 6.1 28.6	kΩ
Resistor Ratio 2112T1/MUN2113T1 N2116T1 N2131T1/MUN2132T1	MUN2111T1/MUN MUN2114T1 MUN2115T1/MU MUN2130T1/MU MUN2133T1 MUN2134T1	R ₁ /R ₂	0.8 0.17 — 0.8 0.055 0.38	1.0 0.21 — 1.0 0.1 0.47	1.2 0.25 — 1.2 0.185 0.56	8



TYPICAL ELECTRICAL CHARACTERISTICS — MUN2111T1



 $\label{eq:collector} I_{\text{C}}, \text{COLLECTOR CURRENT (mA)}$ Figure 6. Input Voltage versus Output Current

0.1

50

TYPICAL ELECTRICAL CHARACTERISTICS — MUN2112T1

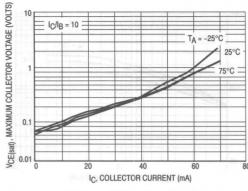


Figure 7. VCE(sat) versus IC

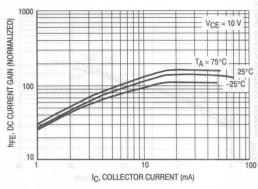


Figure 8. DC Current Gain

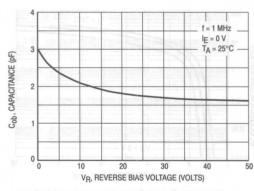


Figure 9. Output Capacitance

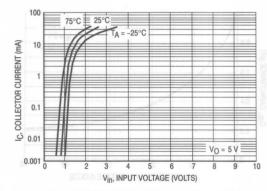


Figure 10. Output Current versus Input Voltage

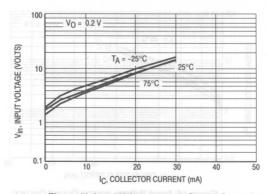


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN2113T1

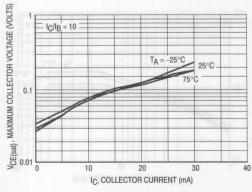


Figure 12. VCE(sat) versus IC

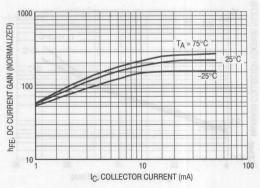


Figure 13. DC Current Gain

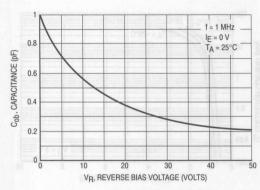


Figure 14. Output Capacitance

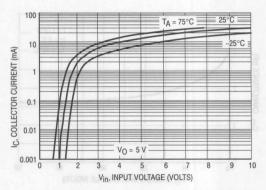


Figure 15. Output Current versus Input Voltage

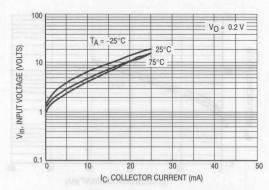
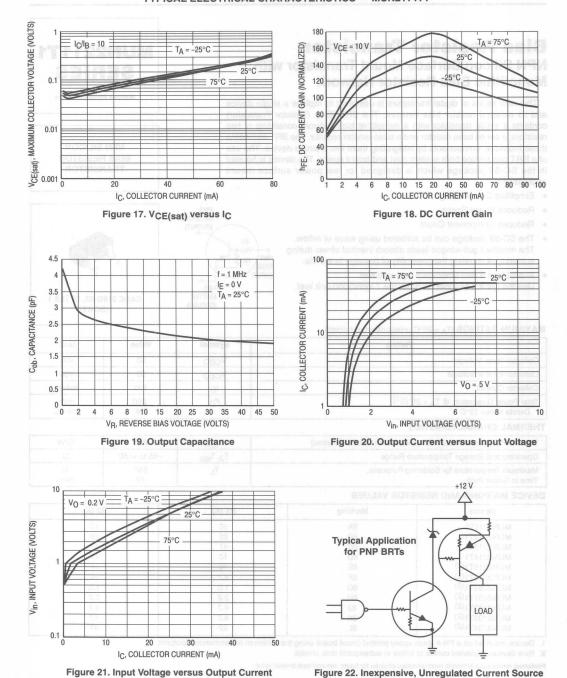


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN2114T1

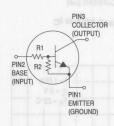


Bias Resistor Transistor

NPN Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base-emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC-59 package which is designed for low power surface mount applications.

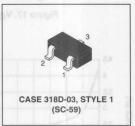
- Simplifies Circuit Design
- Reduces Board Space
- · Reduces Component Count
- The SC-59 package can be soldered using wave or reflow.
 The modified gull-winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
 Use the Device Number to order the 7 inch/3000 unit reel.





Motorola Preferred Devices

NPN SILICON BIAS RESISTOR TRANSISTOR



MAXIMUM RATINGS (TA = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V _{CBO}	50	Vdc
Collector-Emitter Voltage	VCEO	50	Vdc
Collector Current	Ic	100	mAdc
Total Power Dissipation @ T _A = 25°C(1) Derate above 25°C	PD 02 84 05 85 08 83 0	200	mW mW/°C

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)	R ₀ JA	625	°C/W
Operating and Storage Temperature Range	T _J , T _{stg}	-65 to +150	°C
Maximum Temperature for Soldering Purposes, Time in Solder Bath	TL	260 10	°C Sec

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	R2 (K)
MUN2211T1	8A	10	10
MUN2212T1	8B	22	22
MUN2213T1	8C	47	47
MUN2214T1	8D	10	47
MUN2215T1(2)	8E	10	00
MUN2216T1(2)	8F	4.7	00
MUN2230T1(2)	8G	1.0	1.0
MUN2231T1(2)	8H	2.2	2.2
MUN2232T1(2)	8J	4.7	4.7
MUN2233T1(2)	8K	4.7	47
MUN2234T1(2)	8L	22	47

- 1. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.
- 2. New devices. Updated curves to follow in subsequent data sheets.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted)

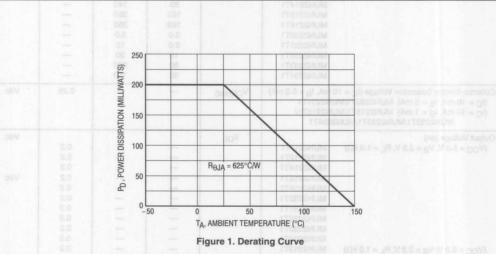
Characteris	tic on to	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	P.6	any (Os	A L = IA V	8.0 - eV V 0.8	se note (to)	named treatmen
Collector-Base Cutoff Current (VCB	= 50 V, I _E = 0)	ІСВО	DESEMBLY ((b) (c) 1 _jA (V)	100	nAdc
Collector-Emitter Cutoff Current (VC	E = 50 V, IB = 0)	ICEO	MUNICOPE	- JA-1	500	nAdc
Emitter-Base Cutoff Current	MUN2211T1	IEBO	DESSIZUM	_	0.5	mAdc
(V _{EB} = 6.0 V, I _C = 0)	141111001071	·EBO	E EDO	_	0.2	
(*EB = 3.3 t, .C = 3)	MUNICOLOTA	110	H SSKIUM	_	0.1	ngut Hasis(dr
			ST SSPILIN	_	0.2	
	MUNICOLETA		U PRIMORE	_	0.9	
	MUNICOLOTI		MUTY2214	_	1.9	
			MUNISSTS	_	4.3	
			AL SISBIETH		2.3	
	MUNICOCCT		MUNISPER		1.5	
			PESSMOM		0.18	
	MUN2234T1		MUNIZION		0.18	
Collector-Base Breakdown Voltage (I _C = 10 μA, I _E = 0)		V _(BR) CBO	50	 	_	Vdc
Collector-Emitter Breakdown Voltage ⁽³⁾ (I _C = 2.0 mA, I _B = 0)		-		THE COMPANY TO	SSMUM	
		V _(BR) CEO	50	170	ocuttilla.	Vdc
ON CHARACTERISTICS(3)			11	Tersshum(rTe	MUNIZZI	
DC Current Gain	MONZZIII	hFE	35	60	ESSMUM.	
(V _{CE} = 10 V, I _C = 5.0 mA)			60	100	<u>118</u> 3118228	
SE O SE	MUN2213T1		80	140	MUNICIPAL CONTRACTOR	
	MUN2214T1		80	140	_	
	MUN2215T1		160	350	_	
	MUN2216T1		160	350	_	
	MUN2230T1		3.0	5.0	_	
	MUN2231T1		8.0	15	_	
	MUN2232T1		15	30	_	
	MUN2233T1		80	200	_	
	MUN2234T1		80	150	_	
Collector-Emitter Saturation Voltage (I _C = 10 mA, I _B = 5 mA) MUN22 (I _C = 10 mA, I _B = 1 mA) MUN22	30T1/MUN2231T1 15T1/MUN2216T1/	VCE(sat)		- 1000 <u>S</u>	0.25	Vdc
MUN2232T1/MUN2233	1 1/10/01/12/23/41 1			3		
Output Voltage (on)		VOL		- 50 50		Vdc
$(V_{CC} = 5.0 \text{ V}, V_B = 2.5 \text{ V}, R_L = 1.00 \text{ M})$			_	100	0.2	
	MUN2212T1	DATE OF THE PARTY		- 9	0.2	
	MUN2214T1	Michell = PSPLOM	-	- 0	0.2	
	MUN2215T1		-	106 _0	0.2	Vdc
	MUN2216T1			_	0.2	
	MUN2230T1		-	_	0.2	
	MUN2231T1	108	_	92 -	0.2	
	MUN2232T1	PART TABLET A	_	_	0.2	
	MUN2233T1	- ima i Priatonie (di	_	_	0.2	
	MUN2234T1	Floure 1. Deras	_	_	0.2	
$(V_{CC} = 5.0 \text{ V}, V_{B} = 3.5 \text{ V}, R_{L} = 1.0 \text{ C})$.0 kΩ) MUN2213T1	CONTRACTOR AND DESCRIPTION OF THE PERSON OF			0.2	

^{3.} Pulse Test: Pulse Width < 300 μ s, Duty Cycle < 2.0%

MUN2211T1 SERIES

ELECTRICAL CHARACTERISTICS (Continued)(T_A = 25°C unless otherwise noted)

	Cha	racteristic		Symbol	Min	Тур	Max	Unit
Output Voltage (off) (V _{CC} =	5.0 V, V _B = 0.5	$V, R_L = 1.0 k\Omega$	Voн	4.9	_	SOUTH RE	Vdc
		$0 \text{ V, R}_{L} = 1.0 \text{ k}\Omega$ V, R _L = 1.0 kΩ)	2) MUN2230T1 MUN2215T1	dept	(0 = 3)		Cutoff Curre	Collegior-Base
(*()) = 0.0 +,	VB - 0.20	v, ri_ = 1.0 raz)	MUN2216T1	OHO!	(0 = g) N		uni Canoft Cure	Collector-Emil
			MUN2233T1	deal d	THISSIUM		nemuO fictus	Emitter-Baset
Input Resistor	9.0	_	MUN2211T1	R1	7.0	10	13	kΩ
•			MUN2212T1		15.4	22	28.6	
			MUN2213T1		32.9	47	61.1	
			MUN2214T1		7.0	10	13	
			MUN2215T1		7.0	10	13	
			MUN2216T1		3.3	4.7	6.1	
			MUN2230T1		0.7	1.0	1.3	Here is a
			MUN2231T1		1.5	2.2	2.9	
			MUN2232T1		3.3	4.7	6.1	
			MUN2233T1		3.3	4.7	6.1	
			MUN2234T1	STATES V	15.4	22	28.6	Collector-Basis
Resistor Ratio	MUN22	11T1/MUN2212	T1/MUN2213T1	R1/R2	0.8	1.0	1.2	CollectorsEn
	MUN22	14T1		arabida. I v.	0.17	0.21	0.25	1.3 (0.000000
	MUN22	15T1/MUN2216	T1		I		(G)60mg181	N CHARACT
	MUN223	30T1/MUN2231	T1/MUN2232T1	and I I	0.8	1.0	1.2	DC Current
	MUN22	33T1		1 1	0.055	0.1	0.185	/Or = moV)
	MUN22	34T1			0.38	0.47	0.56	20047



TYPICAL ELECTRICAL CHARACTERISTICS — MUN2211T1

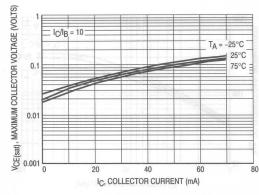


Figure 2. VCE(sat) versus IC

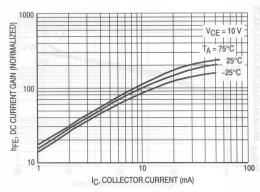


Figure 3. DC Current Gain

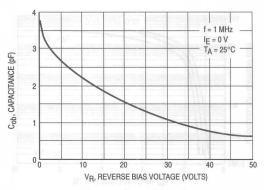


Figure 4. Output Capacitance

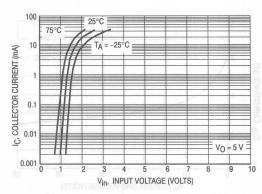


Figure 5. Output Current versus Input Voltage

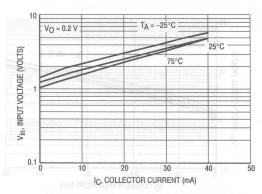


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN2212T1

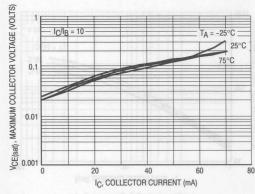


Figure 7. VCE(sat) versus IC

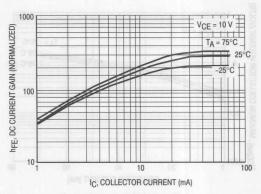


Figure 8. DC Current Gain

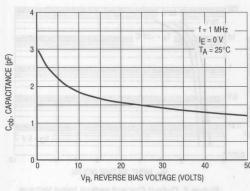


Figure 9. Output Capacitance

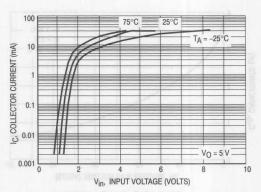


Figure 10. Output Current versus Input Voltage

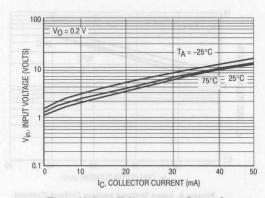


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN2213T1

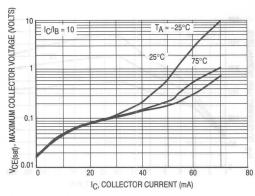


Figure 12. VCE(sat) versus IC

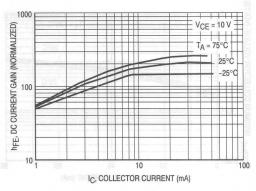


Figure 13. DC Current Gain

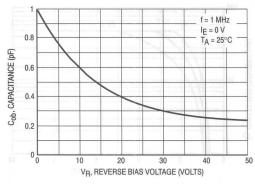


Figure 14. Output Capacitance

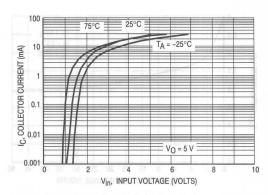


Figure 15. Output Current versus Input Voltage

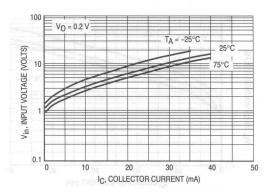


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN2214T1

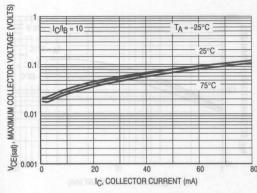


Figure 17. VCE(sat) versus IC

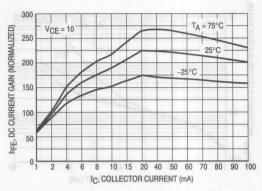


Figure 18. DC Current Gain

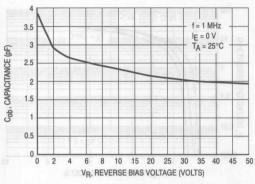


Figure 19. Output Capacitance

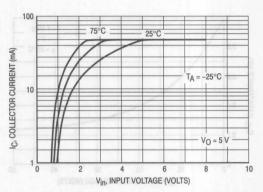


Figure 20. Output Current versus Input Voltage

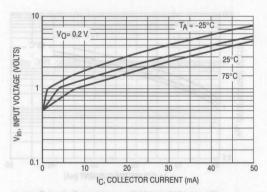


Figure 21. Input Voltage versus Output Current

TYPICAL APPLICATIONS FOR NPN BRTs MOST ROTOUGHOOMAS

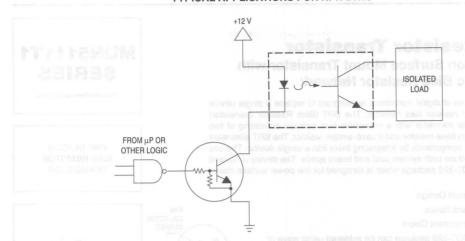


Figure 22. Level Shifter: Connects 12 or 24 Volt Circuits to Logic

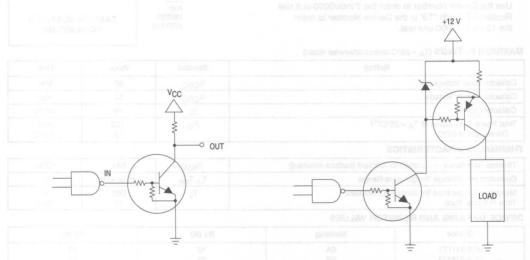


Figure 23. Open Collector Inverter: Inverts the Input Signal

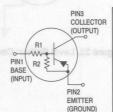
Figure 24. Inexpensive, Unregulated Current Source

Bias Resistor Transistor

PNP Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base-emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC-70/SOT-323 package which is designed for low power surface mount applications.

- · Simplifies Circuit Design
- · Reduces Board Space
- · Reduces Component Count
- The SC-70/SOT-323 package can be soldered using wave or reflow. The modified gull-winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
 Use the Device Number to order the 7 inch/3000 unit reel.
 Replace "T1" with "T3" in the Device Number to order
 the 13 inch/10,000 unit reel.





Motorola Preferred Devices

PNP SILICON BIAS RESISTOR TRANSISTOR



CASE 419-02, STYLE 3 SC-70/SOT-323

MAXIMUM RATINGS (TA = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	VCBO	50	Vdc
Collector-Emitter Voltage	VCEO	50	Vdc
Collector Current	Ic —	50	mAdc
Total Power Dissipation @ T _A = 25°C ⁽¹⁾ Derate above 25°C	PD	150 1.2	mW mW/°C

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)	R ₀ JA	833	°C/W
Operating and Storage Temperature Range	T _J , T _{stg}	-65 to +150	°C
Maximum Temperature for Soldering Purposes, Time in Solder Bath	TL	260 10	°C Sec

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	R2 (K)
MUN5111T1	6A	10	10
MUN5112T1	6B	22	22
MUN5113T1	6C	47	47
MUN5114T1	6D	10	47
MUN5115T1(2)	6E	10	00
MUN5116T1(2)	6F	4.7	00
MUN5130T1(2)	6G	1.0	1.0
MUN5131T1(2)	6H	2.2	2.2
MUN5132T1(2)	6J	4.7	4.7
MUN5133T1(2)	6K	4.7	47
MUN5134T1(2)	6L	22	47

- 1. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.
- 2. New devices. Updated curves to follow in subsequent data sheets.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted)

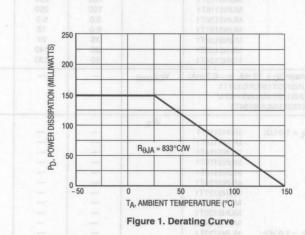
Characteristi	c rank los	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	8.6	10V 10S	RE RV	0 = eV V 0.8	rooVI (flo)	collection to the Collection
Collector-Base Cutoff Current (V _{CB} =	50 V, I _E = 0)	Ісво	ETHNILL (S	14 0.1 <u>—</u> A ,V 0	100	nAdc
Collector-Emitter Cutoff Current (VCE	= 50 V, I _B = 0)	ICEO	travium	10010,1 - JP-W	500	nAdc
Emitter-Base Cutoff Current	MUN5111T1	I _{EBO}	E FBIATIN	_	0.5	mAdc
$(V_{EB} = 6.0 \text{ V}, I_{C} = 0)$	MUN5112T1	179	E FRISH JAM	_	0.2	
	MUN5113T1	re re	Prayon	_	0.1	Note Hauseley
	MUN5114T1	175	rranton	_	0.2	
	MUN5115T1	118	MUNELL		0.9	
	MUN5116T1	178	PERMIT		1.9	
	MUN5130T1	1 Te	Pradum	_	4.3	
	MUN5131T1	178	NUMBER	_	2.3	
	MUN5132T1	170	E1204LTA	_	1.5	
	MUN5133T1	177	NUMB 18	_	0.18	
	MUN5134T1	TIS	S r Britania	_	0.13	
Collector-Base Breakdown Voltage (I	C = 10 μA, I _E = 0)	V(BR)CBO	50	_	_	Vdc
Collector-Emitter Breakdown Voltage	V(BR)CEO	50			Vdc	
ON CHARACTERISTICS(3)	77.0	-4		1TATTa	AUM	Office - Submitted to
DC Current Gain	MUN5111T1	hFE	35	60	IUM	
$(V_{CE} = 10 \text{ V}, I_{C} = 5.0 \text{ mA})$	MUN5112T1	ESST1	60	100	IUM _	
0.185	MUN5113T1		80	140	TUM	
	MUN5114T1		80	140	NUM	
	MUN5115T1		160	250		
	MUN5116T1		160	250	_	
	MUN5130T1		3.0	5.0	_	
	MUN5131T1		8.0	15	_	
	MUN5132T1		15	27		
	MUN5133T1		80	140		
	MUN5134T1		80	130	_	
Collector-Emitter Saturation Voltage ($I_C = 10 \text{ mA}, I_B = 5 \text{ mA}$) MUN513 ($I_C = 10 \text{ mA}, I_B = 1 \text{ mA}$) MUN513 MUN5132T1/MUN5133T	0T1/MUN5131T1 5T1/MUN5116T1/	VCE(sat)		- ANTON (MILLIA	0.25	Vdc
Output Voltage (on)		VOL		au 25		Vdc
$(V_{CC} = 5.0 \text{ V}, V_B = 2.5 \text{ V}, R_L = 1.0 \text{ C})$			-	74	0.2	
	MUN5112T1	R _{0,10} = 803°C		8-	0.2	
	MUN5114T1			3-	0.2	
	MUN5115T1		-	9	0.2	
	MUN5116T1		-	_	0.2	
	MUN5130T1			0	0.2	
	MUN5131T1	E	98-	_	0.2	
	MUN5132T1	ET PARENA, AT	_	_	0.2	
	MUN5133T1	and the second	_	_	0.2	
0		Figure 1. Des	_	_	0.2	
$(V_{CC} = 5.0 \text{ V}, V_{B} = 3.5 \text{ V}, R_{L} = 1.0 \text{ C})$	(0.00) MUN5113T1	1	_	_	0.2	1

^{3.} Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

MUN5111T1 SERIES

ELECTRICAL CHARACTERISTICS (Continued)(TA = 25°C unless otherwise noted)

	Cha	racteristic		Symbol	Min	Тур	Max	Unit
Output Voltage	(off) (V _{CC} =	5.0 V, V _B = 0.5 V	$/$, $R_L = 1.0 \text{ k}\Omega$)	Voн	4.9	_	SOME SERVICE	Vdc
$(V_{CC} = 5.0 \text{ V}, V_B = 0.050 \text{ V}, R_L = 1.0 \text{ k}\Omega)$ MUN5130T1 MUN5115T1 MUN5116T1		apt I to	$\chi 0 = gi \lambda$	08 = goV) In	sa Cutoff Gurre litter Cutoff Gur			
		BOI	(0 = gl ,V (a = 35V) Inev		Collector-En		
			MUN5131T1 MUN5132T1	17	MUNISTE		Cutoff Cunain	Emitter-Base
Input Resistor	1.0		MUN5111T1	R1	7.0	10	13	kΩ
			MUN5112T1	17	15.4	22	28.6	
			MUN5113T1	THE PERSON NAMED IN	32.9	47	61.1	
		-	MUN5114T1	L I I I I	7.0	10	13	
			MUN5115T1	111	7.0	10	13	THE PARTY
			MUN5116T1	TI-	3.3	4.7	6.1	
			MUN5130T1	1.17	0.7	1.0	1.3	
			MUN5131T1	I IB	1.5	2.2	2.9	
			MUN5132T1	THE STREET	3.3	4.7	6.1	
			MUN5133T1	Marco	3.3	4.7	6.1	of salestin
			MUN5134T1	Loan L	15.4	22	28.6	aca-tizapenoto
Resistor Ratio	MUN	5111T1/MUN5112	T1/MUN5113T1	R ₁ /R ₂	0.8	1.0	1.2	10700000
	MUN	I5114T1			0.17	0.21	0.25	DAFIANO M
MUN5115T1/MUN5116T1			ent it	MUNSTER	_	- rest	InimuS DO	
	MUN	15130T1/MUN513	1T1/MUN5132T1	17	0.8	1.0	- 1.2	(Vog = 10
	MUN	I5133T1		17	0.055	0.1	0.185	
	MUN	I5134T1		17	0.38	0.47	0.56	



100

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5111T1

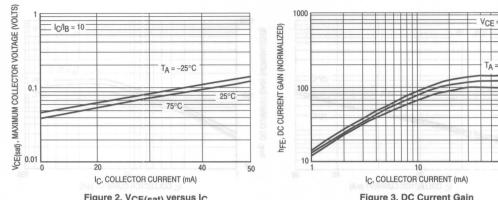


Figure 2. VCE(sat) versus IC



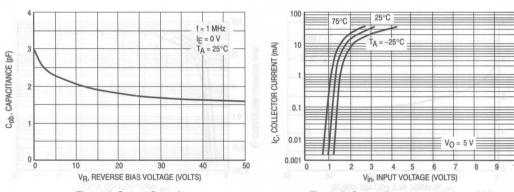


Figure 4. Output Capacitance

Figure 5. Output Current versus Input Voltage

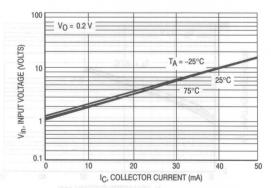
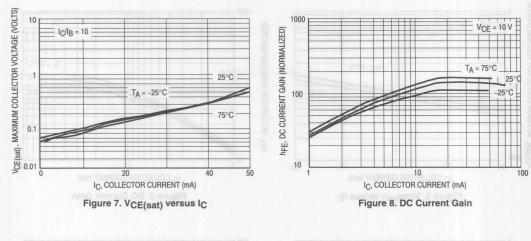
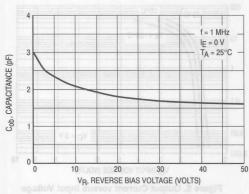


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5112T1







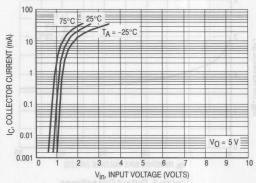


Figure 10. Output Current versus Input Voltage

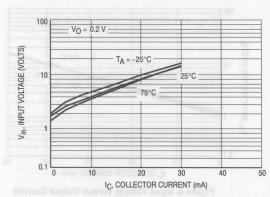


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5113T1

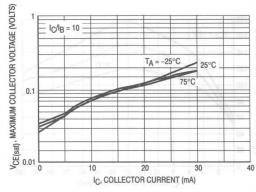


Figure 12. VCE(sat) versus IC

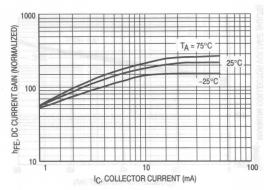


Figure 13. DC Current Gain

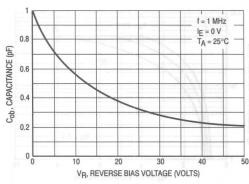


Figure 14. Output Capacitance

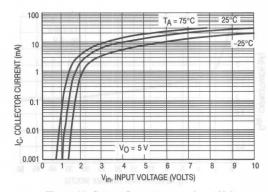


Figure 15. Output Current versus Input Voltage

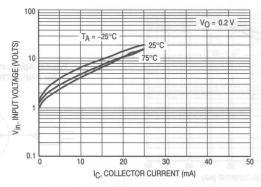


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5114T1

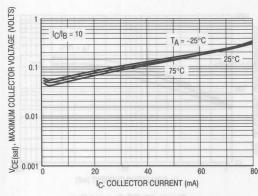


Figure 17. VCE(sat) versus IC

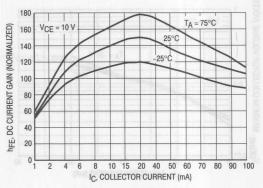


Figure 18. DC Current Gain

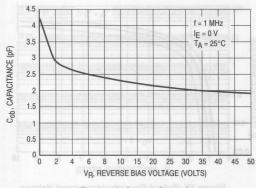


Figure 19. Output Capacitance

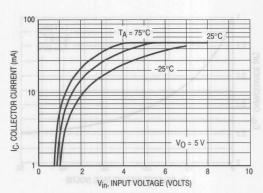


Figure 20. Output Current versus Input Voltage

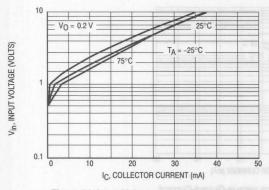


Figure 21. Input Voltage versus Output Current

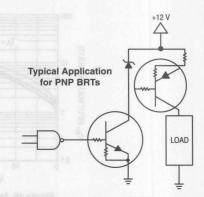


Figure 22. Inexpensive, Unregulated Current Source

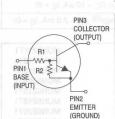
Monolithic Bias Resistor Network

Bias Resistor Transistor NPN Silicon Surface Mount Transistor with

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base-emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC-70/SOT-323 package which is designed for low power surface mount applications.



- · Reduces Board Space
- · Reduces Component Count
- The SC-70/SOT-323 package can be soldered using wave or reflow. The modified gull-winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
 Use the Device Number to order the 7 inch/3000 unit reel.
 Replace "T1" with "T3" in the Device Number to order the
 13 inch/10.000 unit reel.





Motorola Preferred Devices

NPN SILICON

BIAS RESISTOR

TRANSISTORS

CASE 419-02, STYLE 3 SC-70/SOT-323

MAXIMUM RATINGS (TA = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V _{CBO}	50	Vdc
Collector-Emitter Voltage	V _{CEO} MAT	er 58 MU 50 Am F =	Vdc (Vdc
Collector Current	IC	50	mAdc
Total Power Dissipation @ T _A = 25°C ⁽¹⁾ Derate above 25°C	PD (C)	150	mW mW/°C

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)	R ₀ JA	833	°C/W
Operating and Storage Temperature Range	T _J , T _{stg}	-65 to +150	°C
Maximum Temperature for Soldering Purposes, Time in Solder Bath	ETTESRIAUITL ETTESRIAUM	260 10	°C Sec

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	JR V 8 8 = R2 (K) = 00V)
MUN5211T1	8A	s. Duty Dyole < 101%	3. Pulse Trial 01:e Width < 300 i
MUN5212T1	8B	22	22
MUN5213T1	8C	47	47
MUN5214T1	8D	10	47
MUN5215T1(2)	8E	10	00
MUN5216T1(2)	8F	4.7	00
MUN5230T1(2)	8G	1.0	1.0
MUN5231T1(2)	8H	2.2	2.2
MUN5232T1(2)	8J	4.7	4.7
MUN5233T1(2)	8K	4.7	47
MUN5234T1(2)	8L	22	47

- 1. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.
- 2. New devices. Updated curves to follow in subsequent data sheets.

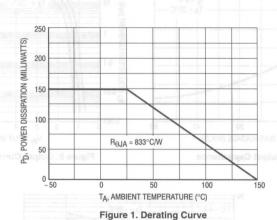
Preferred devices are Motorola recommended choices for future use and best overall value.

MUN5211T1 SERIES

Characteristic		Symbol	Min	Тур	Max	Unit
FF CHARACTERISTICS						
Collector-Base Cutoff Current (V _{CB} = 50 V, I _E	E = 0)	ІСВО	els - no	OF TO	100	nAdc
Collector-Emitter Cutoff Current (V _{CE} = 50 V,	, I _B = 0)	ICEO	as Throng	AM TOO	500	nAdc
Emitter-Base Cutoff Current	MUN5211T1	IEBO			0.5	mAdc
$(V_{EB} = 6.0 \text{ V}, I_{C} = 0)$	MUN5212T1	200	SANTENT S	breizau	0.2	HIORO
	MUN5213T1	ta e poplace of	Harrisott si	esalulo appl 1	0.1	work alth
	MUN5214T1	antidoo E paid	TRR wit	besides col	0.2	alva ati l
	MUN5215T1	Manuscon illended	poid oletilo	ners a ctilia s	0.9	a a salas
	MUN5216T1 MUN5230T1	PR or T votate	in nicitizata da	ed a base note	4.3	o a resoluti
	MUN5231T1	dental alamin a d	mi mest noi	is hterrance	2.3	hivihni sa
	MUN5232T1	strain of T and	on the - of her	o tano — atava	1.5	USO TERM
	MUN5233T1	den sausvarauent s	of her—lash	ai rinin u a nco	0.18	05.732 an
	MUN5234T1		_	-	0.13	should one.
Collector-Base Breakdown Voltage ($I_C = 10 \mu$		V _(BR) CBO	50	- 1	Circuit Design	Vdc
Collector-Emitter Breakdown Voltage(3) (IC =	= 2.0 mA, I _B = 0)	V(BR)CEO	50	_	soaq 3 b isot	Vdc
ON CHARACTERISTICS(3)				Inuc	O menogino	Reduces
DC Current Gain	MUN5211T1	10 hFE 1914	35	60	1901_323 pa	The SC-7
$(V_{CE} = 10 \text{ V}, I_{C} = 5.0 \text{ mA})$	MUN5212T1	ezente Isrma	60	100	lig belleam s	reflow. Th
	MUN5213T1	age to the die.	80	140	arimit o g rinek	during sol
	MUN5214T1		80	140	sime min 8 n	Available
	MUN5215T1	lear finu	160	350	udould solve	lea tha D
	MUN5216T1	riger the	160	350	Corre ellips for	Papiling 1
	MUN5230T1		3.0	5.0	Joen tinu 000)	Pridoni 81
	MUN5231T1 MUN5232T1		8.0 15	15 30	A SECTION AND ASSESSMENT	
	MUN5233T1	160	80	200	ATINES (TA	A DEUMEN
	MUN5234T1		80	150	THE PERSON NAMED IN	THE CHARLES
			00	100		
Collector-Emitter Saturation Voltage (I _C = 10 $$ MUN5230T1/MU (I _C = 10 $$ mA, I _B = 5 $$ mA) $$ MUN5230T1/MU (I _C = 10 $$ mA, I _B = 1 $$ mA) $$ MUN5215T1/MUN5232T1/MUN5233T1/MUN523T1/MUN523T1/MUN523T1/MUN52	mA, I _B = 0.3 mA) JN5231T1 JN5216T1	VCE(sat)	_	_	0.25	Vdc
$(I_C = 10 \text{ mA}, I_B = 5 \text{ mA}) \text{ MUN5230T1/MU}$ $(I_C = 10 \text{ mA}, I_B = 1 \text{ mA}) \text{ MUN5215T1/MU}$	mA, I _B = 0.3 mA) JN5231T1 JN5216T1		-	1000	eganov az	ollector-Dr ollector-Dr ollector Ou
$(I_C = 10 \text{ mA}, I_B = 5 \text{ mA}) \text{ MUN5230T1/MU} $ $(I_C = 10 \text{ mA}, I_B = 1 \text{ mA}) \text{ MUN5215T1/MU} $ $(I_C = 10 \text{ mA}, I_B = 1 \text{ mA}) MUN5233T1/MUN523T1/MUN$	mA, I _B = 0.3 mA) JN5231T1 JN5216T1	VCE(sat)	_	(t)oras = A	eganov az	(G-lothello
(I _C = 10 mA, I _B = 5 mA) MUN5230T1/MU (I _C = 10 mA, I _B = 1 mA) MUN5215T1/MU MUN5232T1/MUN5233T1/MUN5 Output Voltage (on)	mA, I _B = 0.3 mA) JN5231T1 JN5216T1 3234T1			1000	0.2	Vdc
$\label{eq:controller} \begin{array}{l} \text{(I_{C}=10mA,I_{B}=5mA)} \ \ \text{MUN5230T1/MU} \\ \text{(I_{C}=10mA,I_{B}=1mA)} \ \ \text{MUN5215T1/MU} \\ \text{MUN5232T1/MUN5233T1/MUN5233T1/MUN5} \\ \text{Output Voltage (on)} \\ \text{(V_{CC}=5.0 V, V_{B}=2.5 V, R_{L}=1.0 k}\Omega) \\ \end{array}$	mA, IB = 0.3 mA) IN5231T1 IN5216T1 I234T1 MUN5211IT1 MUN5212T1 MUN5214T1			1000	0.2 0.2 0.2 0.2	Vdc
(I _C = 10 mA, I _B = 5 mA) MUN5230T1/MU (I _C = 10 mA, I _B = 1 mA) MUN5215T1/MU MUN5232T1/MUN5233T1/MUN5 Output Voltage (on)	MA, IB = 0.3 mA) IN5231T1 IN5216T1 I234T1 MUN5211IT1 MUN5212T1 MUN5214T1 MUN5215T1		m scartus) i	1000	0.2 0.2 0.2 0.2 0.2	Vdc
$\label{eq:controller} \begin{array}{l} \text{(I_{C}=10mA,I_{B}=5mA)} \ \ \text{MUN5230T1/MU} \\ \text{(I_{C}=10mA,I_{B}=1mA)} \ \ \text{MUN5215T1/MU} \\ \text{MUN5232T1/MUN5233T1/MUN5233T1/MUN5} \\ \text{Output Voltage (on)} \\ \text{(V_{CC}=5.0 V, V_{B}=2.5 V, R_{L}=1.0 k}\Omega) \\ \end{array}$	MA, IB = 0.3 mA) IN5231T1 IN5216T1 IN5216T1 IN5211IT1 MUN5212T1 MUN5214T1 MUN5215T1 MUN5216T1	VoL	an samus) a	1000	0.2 0.2 0.2 0.2 0.2 0.2	Vdc
$(I_C = 10 \text{ mA, } I_B = 5 \text{ mA}) \ \text{MUN5230T1/MU} \\ (I_C = 10 \text{ mA, } I_B = 1 \text{ mA}) \ \text{MUN5215T1/MU} \\ \text{MUN5232T1/MUN5233T1/MUN5233T1/MUN5} \\ \text{Output Voltage (on)} \\ (V_{CC} = 5.0 \text{ V, } V_B = 2.5 \text{ V, } R_L = 1.0 \text{ k}\Omega) \\ \end{cases}$	MA, IB = 0.3 mA) JN5231T1 JN5216T1 J234T1 MUN5211IT1 MUN5212T1 MUN5214T1 MUN5216T1 MUN5216T1 MUN5230T1	VoL	om ac mus) n	1000	0.2 0.2 0.2 0.2 0.2 0.2	Vdc
$ \begin{aligned} &(I_C = 10 \text{ mA, } I_B = 5 \text{ mA}) & \text{MUN5230T1/MU} \\ &(I_C = 10 \text{ mA, } I_B = 1 \text{ mA}) & \text{MUN5215T1/MU} \\ & \text{MUN5232T1/MUN5233T1/MUN5233T1/MUN5} \\ &\text{Output Voltage (on)} \\ &(V_{CC} = 5.0 \text{ V, } V_B = 2.5 \text{ V, } R_L = 1.0 \text{ k}\Omega) \end{aligned} $	MA, IB = 0.3 mA) IN5231T1 IN5216T1 IN5216T1 IN5214T1 MUN5212T1 MUN5214T1 MUN5215T1 MUN5216T1 MUN5230T1 MUN5230T1 MUN5231T1	VoL	n (sumus nic	1000	0.2 0.2 0.2 0.2 0.2 0.2 0.2	Vdc
$(I_{C} = 10 \text{ mA, } I_{B} = 5 \text{ mA}) \ \text{MUN5230T1/MU} \\ (I_{C} = 10 \text{ mA, } I_{B} = 1 \text{ mA}) \ \text{MUN5215T1/MU} \\ \text{MUN5232T1/MUN5233T1/MUN5233T1/MUN5} \\ \text{Output Voltage (on)} \\ (V_{CC} = 5.0 \text{ V, } V_{B} = 2.5 \text{ V, } R_{L} = 1.0 \text{ k}\Omega) \\ \end{cases}$	MA, IB = 0.3 mA) IN5231T1 IN5216T1 I234T1 MUN5211IT1 MUN5212T1 MUN5214T1 MUN5215T1 MUN5216T1 MUN5230T1 MUN5231T1 MUN5232T1	VoL		STICE STICE SOCIETION SOCIETIO	0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	Vdc standard a gritished a gri
$(I_C = 10 \text{ mA}, I_B = 5 \text{ mA})$ MUN5230T1/MU $(I_C = 10 \text{ mA}, I_B = 1 \text{ mA})$ MUN5215T1/MU MUN5232T1/MUN5233T1/MUN5233T1/MUN5233T1/MUN523ST1/MUN52ST1/MUN5	MA, IB = 0.3 mA) IN5231T1 IN5216T1 IN5216T1 IN5214T1 MUN5212T1 MUN5214T1 MUN5215T1 MUN5216T1 MUN5230T1 MUN5230T1 MUN523T1 MUN5233T1 MUN5233T1 MUN5234T1	VoL	1 (su = 16 pt) 1 1 2 2 pt; 2008. –	1000	0.2 0.2 0.2 0.2 0.2 0.2 0.2	Vdc
$\label{eq:continuous} \begin{array}{l} \text{(I_C = 10 mA, I_B = 5 mA)} & \text{MUN5230T1/MU} \\ \text{(I_C = 10 mA, I_B = 1 mA)} & \text{MUN5215T1/MU} \\ & MUN5232T1/MUN5233T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN523T$	MA, IB = 0.3 mA) IN5231T1 IN5216T1 IN5216T1 IN5214T1 MUN5212T1 MUN5214T1 MUN5215T1 MUN5216T1 MUN5230T1 MUN5230T1 MUN523T1 MUN5232T1 MUN5233T1 MUN5233T1 MUN5234T1 MUN5231T1	VoL	k (sum of mo	STICE STICE SOCIETION SOCIETIO	0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	Vdc standard a gritished a gri
$(I_{C} = 10 \text{ mA}, I_{B} = 5 \text{ mA}) \text{ MUN5230T1/MU} \\ (I_{C} = 10 \text{ mA}, I_{B} = 1 \text{ mA}) \text{ MUN5215T1/MU} \\ MUN5232T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5232T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN523T1/MUN52T1/MUN523T1/MUN523T1/MUN52T1/MU$	MA, IB = 0.3 mA) IN5231T1 IN5216T1 IN5216T1 IN5214T1 MUN5212T1 MUN5214T1 MUN5215T1 MUN5216T1 MUN5230T1 MUN5230T1 MUN523T1 MUN5232T1 MUN5233T1 MUN5233T1 MUN5234T1 MUN5231T1	VoL	A (sumos me sous) A sous me so	STICE STICE SOCIETION SOCIETIO	0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	Vdc string JAMF3 of lomed of controls of string of string of string of string of string
$(I_{C} = 10 \text{ mA}, I_{B} = 5 \text{ mA}) \text{ MUN5230T1/MU} \\ (I_{C} = 10 \text{ mA}, I_{B} = 1 \text{ mA}) \text{ MUN5215T1/MU} \\ MUN5232T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5232T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN523T1/MUN52T1/MUN523T1/MUN523T1/MUN52T1/MU$	MA, IB = 0.3 mA) IN5231T1 IN5216T1 IN5216T1 IN5214T1 MUN5212T1 MUN5214T1 MUN5215T1 MUN5216T1 MUN5230T1 MUN5230T1 MUN523T1 MUN5232T1 MUN5233T1 MUN5233T1 MUN5234T1 MUN5231T1	VoL	k (sum of mo	STICE STICE SOCIETION SOCIETIO	0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	Vdc string JAMF3 of lomed of controls of string of string of string of string of string
$(I_C = 10 \text{ mA, } I_B = 5 \text{ mA}) \text{ MUN5230T1/MU} \\ (I_C = 10 \text{ mA, } I_B = 1 \text{ mA}) \text{ MUN5215T1/MU} \\ MUN5232T1/MUN5233T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN523T1/MUN523T1/MUN523T1/MUN523T1/MUN5232T1/MUN5233T1/MUN523T1/MUN523T1/MUN523T1/MUN5233T1/MUN5233T1/MUN5233T1/MUN523T1/MUN5$	MA, IB = 0.3 mA) IN5231T1 IN5216T1 I234T1 MUN5212T1 MUN5212T1 MUN5215T1 MUN5215T1 MUN5230T1 MUN5230T1 MUN523T1	VoL	A (sumos me sous) A sous me so	STICE STICE SOCIETION SOCIETIO	0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	2 nazello 2 vocalio v Vdc netrical IAM IAM IAM IAM IAM IAM IAM IAM IAM IAM IAM IAM IAM
$(I_C=10~\text{mA}, I_B=5~\text{mA})~\text{MUN5230T1/MU} \\ (I_C=10~\text{mA}, I_B=1~\text{mA})~\text{MUN5215T1/MU} \\ ~MUN5232T1/MUN5233T1/MUN5233T1/MUN5233T1/MUN5233T1/MUN5233T1/MUN5233T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN5232T1/MUN5233T1/MUN523T1/MUN5$	MA, IB = 0.3 mA) JN5231T1 JN5216T1 JN5216T1 JN5214T1 MUN5212T1 MUN5214T1 MUN5215T1 MUN523T1	VoL	A (surros nic s ses. ALUES Javidno 38 86	STICE STICE SOCIETION SOCIETIO	0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	2 nazello 2 vocalio v Vdc netrical IAM IAM IAM IAM IAM IAM IAM IAM IAM IAM IAM IAM IAM
$(I_C=10~\text{mA}, I_B=5~\text{mA}) \ \text{MUN5230T1/MU} \\ (I_C=10~\text{mA}, I_B=1~\text{mA}) \ \text{MUN5215T1/MU} \\ \text{MUN5232T1/MUN5233T1/MUN5233T1/MUN5} \\ \text{Output Voltage (on)} \\ (V_{CC}=5.0~\text{V}, V_B=2.5~\text{V}, R_L=1.0~\text{k}\Omega) \\ \\ (V_{CC}=5.0~\text{V}, V_B=3.5~\text{V}, R_L=1.0~\text{k}\Omega) \\ \text{Pulse Test: Pulse Width } < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}, \text{ Duty Cycle} \\ \text{Test: Pulse Width} < 300~\mu\text{s}$	mA, IB = 0.3 mA) IN5231T1 IN5216T1 IN5216T1 IN5214T1 MUN5212T1 MUN5214T1 MUN5215T1 MUN523T1 MUN5230T1 MUN523T1	VoL	A (surros nic s ses. ALUES Javidno 38 86	STICE STICE SOCIETION SOCIETIO	0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	Vdc a shad a gatsae, a gat
(I _C = 10 mA, I _B = 5 mA) MUN5230T1/MU (I _C = 10 mA, I _B = 1 mA) MUN5215T1/MU MUN5232T1/MUN5232T1/MUN5233T1/MUN5233T1/MUN5 (V _{CC} = 5.0 V, V _B = 2.5 V, R _L = 1.0 kΩ) $(V_{CC} = 5.0 \text{ V}, V_{B} = 3.5 \text{ V}, R_{L} = 1.0 \text{ k}\Omega)$ (V _{CC} = 5.0 V, V _B = 3.5 V, R _L = 1.0 kΩ)	mA, IB = 0.3 mA) IN5231T1 IN5216T1 IN5216T1 IN5214T1 MUN5212T1 MUN5214T1 MUN5215T1 MUN523T1	VoL	A (surface ms. sees. sees. sees. sees. sees. sees. sees. see see	STICE STICE SOCIETION SOCIETIO	0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	3 variable of the control of the con
$(I_C=10~\text{mA}, I_B=5~\text{mA}) \ \text{MUN5230T1/MU} \\ (I_C=10~\text{mA}, I_B=1~\text{mA}) \ \text{MUN5215T1/MU} \\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ $	mA, I _B = 0.3 mA) IN5231T1 IN5216T1 IN5216T1 IN5214T1 MUN5212T1 MUN5214T1 MUN5215T1 MUN5216T1 MUN5230T1 MUN5230T1 MUN523T1	VoL	ALUES ALUES Backing BA BA BA BA BA BA BA BA BA B	STICE STICE SOCIETION SOCIETIO	0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	Vdc string LAMFE A format antises, mumas as al anti M 30W
$(I_C=10~\text{mA}, I_B=5~\text{mA}) \ \text{MUN5230T1/MU} \\ (I_C=10~\text{mA}, I_B=1~\text{mA}) \ \text{MUN5215T1/MU} \\ \ \ MUN5232T1/MUN5233T1/MUN523T1/MU$	mA, IB = 0.3 mA) IN5231T1 IN5216T1 IN5216T1 IN5214T1 MUN5212T1 MUN5214T1 MUN5215T1 MUN523T1	VoL	A (surface ms. sees. sees. sees. sees. sees. sees. sees. see see	STICE STICE SOCIETION SOCIETIO	0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	Jamasilo Jam

ELECTRICAL CHARACTERISTICS (Continued)(T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Тур	Max	Unit
Output Voltage (off) $(V_{CC} = 5.0 \text{ V}, V_B = 0.5 \text{ V})$ $(V_{CC} = 5.0 \text{ V}, V_B = 0.050 \text{ V}, R_L = 1.0 \text{ k}\Omega)$ $(V_{CC} = 5.0 \text{ V}, V_B = 0.25 \text{ V}, R_L = 1.0 \text{ k}\Omega)$	VOH	4.9		- 97 -	Vdc	
Input Resistor	MUN5211T1 MUN5212T1 MUN5213T1 MUN5213T1 MUN5215T1 MUN5216T1 MUN5230T1 MUN5231T1 MUN5232T1 MUN5233T1 MUN5233T1 MUN5233T1	R1	7.0 15.4 32.9 7.0 7.0 3.3 0.7 1.5 3.3 3.3 15.4	10 22 47 10 10 4.7 1.0 2.2 4.7 4.7	13 28.6 61.1 13 13 6.1 1.3 2.9 6.1 6.1 28.6	kΩ 10.0
Resistor Ratio MUN5211T1/MUN5212 MUN5214T1 MUN5215T1/MUN5210 MUN5230T1/MUN523 MUN5233T1 MUN5234T1	6T1	R1/R2	0.8 0.17 — 0.8 0.055 0.38	1.0 0.21 — 1.0 0.1 0.47	1.2 0.25 — 1.2 0.185 0.56	1



TYPICAL ELECTRICAL CHARACTERISTICS — MUN5211T1

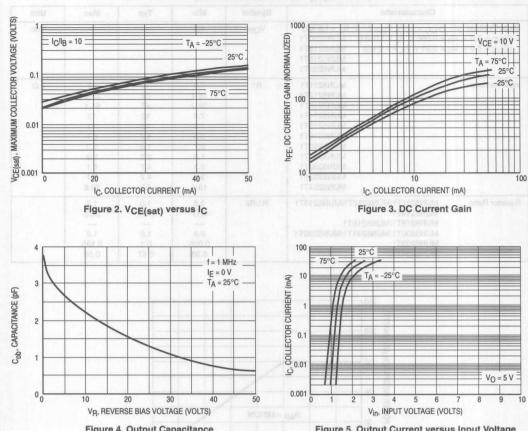


Figure 4. Output Capacitance

Figure 5. Output Current versus Input Voltage

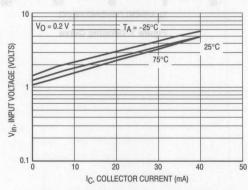


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5212T1

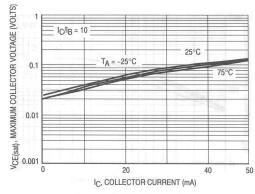


Figure 7. VCE(sat) versus IC

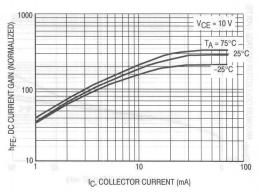


Figure 8. DC Current Gain

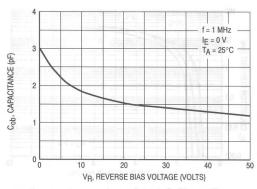


Figure 9. Output Capacitance

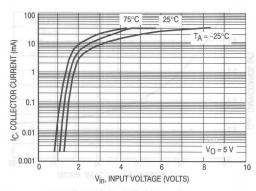


Figure 10. Output Current versus Input Voltage

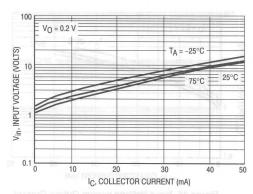


Figure 11. Input Voltage versus Output Current

MUN5211T1 SERIES

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5213T1

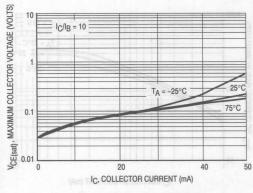


Figure 12. VCE(sat) versus IC

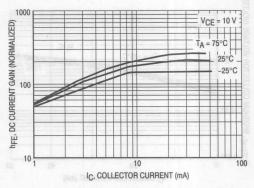


Figure 13. DC Current Gain

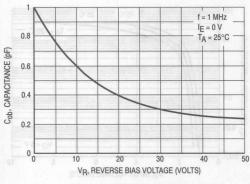


Figure 14. Output Capacitance

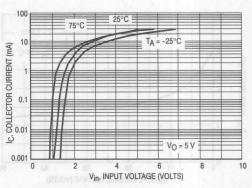


Figure 15. Output Current versus Input Voltage

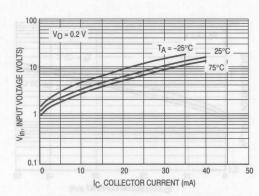


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5214T1

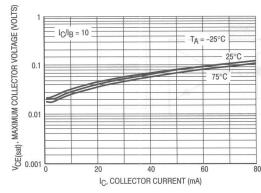


Figure 17. VCE(sat) versus IC

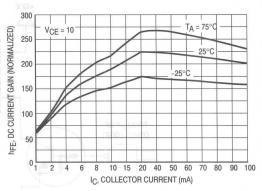


Figure 18. DC Current Gain

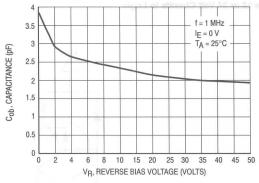


Figure 19. Output Capacitance

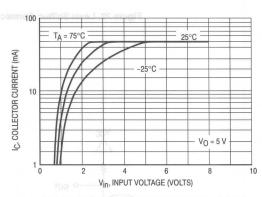


Figure 20. Output Current versus Input Voltage

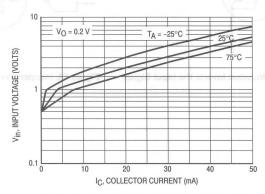


Figure 21. Input Voltage versus Output Current

TYPICAL APPLICATIONS FOR NPN BRTs

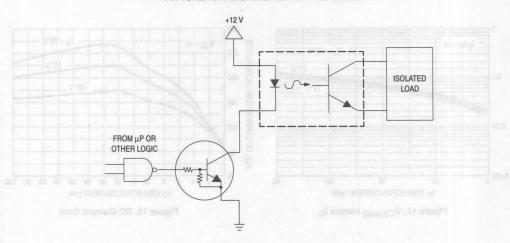


Figure 22. Level Shifter: Connects 12 or 24 Volt Circuits to Logic

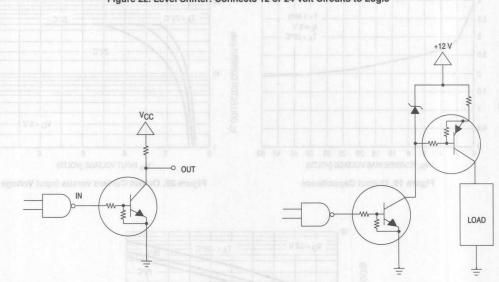


Figure 23. Open Collector Inverter: Inverts the Input Signal

Figure 24. Inexpensive, Unregulated Current Source

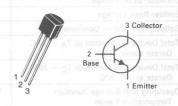
Rating	Symbol	PBF259,S	Unit
Collector-Emitter Voltage	VCEO	300	Vdc
Collector-Base Voltage	VCBO	300	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current - Continuous	IC	500	mAdc
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	625 5.0	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic ALOV ME	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	Raic	83.3	°C/W

PBF259, S

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to MPSA42 for graphs.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS				BUHERMET	Ananu 13
Collector-Emitter Breakdown Voltage (1) (I _C = 1.0 mAdc, I _B = 0)	1) 9	V(BR)CEO	300	= glzbAn	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu Adc, I_E = 0$)	7.4	V(BR)CBO	300	Adc Tg = 0	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)) 4	V(BR)EBO	5.0	= of thAu	Vdc
Collector Cutoff Current (V _{CB} = 250 Vdc, I _E = 0)		ICBO	- (0	50	nAdc
Emitter Cutoff Current (VEB = 3.0 V)		I _{EBO}	_	20	nAdc
Collector Cutoff Current (VCE = 10 V)		ICEO	-	50	nAdc
ON CHARACTERISTICS (1)			- (1	1 OUR 1 O. P. 21	Jewsking en
DC Current Gain (I _C = 20 mAdc, V_{CE} = 10 Vdc) (I _C = 1.0 mAdc, V_{CE} = 10 Vdc) (I _C = 30 mAdc, V_{CE} = 10 Vdc)	PBF259S All Types All Types	hFE	60 25 25	abV pAn	$\frac{10}{10} = 20$ m $\frac{10}{10} = 20$ m $\frac{10}{10} = 30$ m $\frac{10}{10} = 30$ m
Collector-Emitter Saturation Voltage (I _C = 30 mAdc, I _B = 1.5 mAdc) (I _C = 30 mAdc, I _B = 60 mAdc)		VCE(sat)	S mAde)	0.5 1.0	100
SMALL-SIGNAL CHARACTERISTICS			(Am	A la = 2.6	680 ± 0.00
Current-Gain Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 20 MHz)		fT	40	IARAH. JARAN	MHz
Output Capacitance (VCB = 20 Vdc, IF = 0, f = 1.0 MHz)		C _{obo}	10 Vdc. 1 =	3.0	or pF

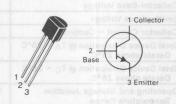
Rating	Symbol	PBF493RS	Unit
Collector-Emitter Voltage	VCEO	300	Vdc
Collector-Base Voltage	V _{CBO}	300	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	Ic	500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

PBF259RS

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to MPSA92 for graphs.

Ch	aracteristic	Phonest Contraction of State	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	townito		000014000100	4		A # 5 1 Sc. Page
Collector-Emitter Breakdown Voltage (I _C = 3.0 mAdc, I _B = 0)	(1) OBORRAIV		V(BR)CEO	300	nitter Breakd	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu Adc, I_E = 0$)	ОвојивјУ		V(BR)CBO	300	wobsteen8 ea	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μ Adc, I _C = 0)	OSB(RB)V		V(BR)EBO	5.0	two bleed own	Vdc
Collector Cutoff Current (V _{CB} = 250 Vdc, I _E = 0)	0831		ICBO	- 19	50	nAdc
Emitter Cutoff Current (VEB = 3.0 V)	OBBI		IEBO	10	20	nAdc
Collector Cutoff Current (V _{CE} = 10 V)	0304		ICEO	-	50	nAdc
ON CHARACTERISTICS (1)					143	- 308
DC Current Gain (I _C = 20 mAdc, V _{CE} = 10 Vdc) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc)	gad	PBF25593 All Tyres	hFE	60 25 25	Gain_ mAdo_Vos mAdo_Vos	(IC = 1.0)
Collector-Emitter Saturation Voltage ($I_C = 30 \text{ mAdc}$, $I_B = 1.5 \text{ mAdc}$) ($I_C = 30 \text{ mAdc}$, $I_B = 60 \text{ mAdc}$)	VCE(sat)	30001 120	VCE(sat)	opation V <u>al</u> tage ion V <u>al</u> tage i.5 m <u>Ad</u> el	0.5 1.0	Vdc
Base-Emitter Saturation Voltage (I _C = 20 mA, I _B = 2.0 mA)			V _{BE(sat)}	SOLLSHELL	0.9	V
SMALL-SIGNAL CHARACTERISTICS	Ti I			Product	dibliobage in	Current-Gail
Current-Gain Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f =	20 MHz)		fT	40	eonstia	MHz
Output Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 1.0 MH	z)		C _{obo}	100 - 10	3.0	pF

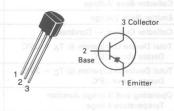
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	ob∀ −300 0	Vdc
Collector-Base Voltage	VCBO	sbV −300 04	Vdc
Emitter-Base Voltage	VEBO	ob∀ -5.0 0	Vdc
Collector Current — Continuous	IC	-500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	or eo°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

PBF493, S

CASE 29-04, STYLE 1 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

PNP SILICON

Refer to MPSA92 for graphs.

sted settle cha	racteristic			Symbol	Min	Max	Unit
OFF CHARACTERISTICS						SOTTENETTON	RAND TH
Collector-Emitter Breakdown Voltage(1 (I _C = -1.0 mAdc, I _B = 0)	V(BR)CEC			V(BR)CEO	- 300	mit e -t ireakti .0 mAdo, la	Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc, I_E = 0$)	V(BR)CRO			V(BR)CBO	-300	obske st å se s	Vdc
Emitter-Base Breakdown Voltage (I _E = -100μ Adc, I _C = 0)	OSE(SE)V			V(BR)EBO	-5.0	se Porsidow	Vdc
Collector Cutoff Current (V _{CB} = -200 Vdc, I _E = 0)	0.801			ICBO	- (0 =	-0.25	μAdc
Emitter Cutoff Current (VEB = -3.0 V)	083			IEBO	-	-20	nAdc
Collector Cutoff Current (VCE = -10 V)	0901			ICEO	-	- 250	nAdc
ON CHARACTERISTICS(1)						SUITE ETU.	ARAHD W
$\begin{array}{ll} \text{DC Current Gain} \\ \text{(I}_{C} = -0.1 \text{ mAdc, V}_{CE} = -1.0 \text{ Vdc)} \\ \text{(I}_{C} = -1.0 \text{ mAdc, V}_{CE} = -10 \text{ Vdc)} \\ \text{(I}_{C} = -30 \text{ mAdc, V}_{CE} = -10 \text{ Vdc)} \end{array}$	344	PBF493S All Types All Types	Regard Types Types	hFE (3)	40 40 25	Sein 1.1 m eu le, Vg 1.0 m eu le, Vg 20 m eu le, Vga	nemu 3 00 - = 50 - = 50
Collector-Emitter Saturation Voltage ($I_C = -20 \text{ mAdc}$, $I_B = -2.0 \text{ mAdc}$)	VCE(set)			VCE(sat)	tion Vo ltage	-0.5	Vdc
Base-Emitter Saturation Voltage (I _C = -20 mAdc, I _B = -2.0 mAdc)	VBE(sat)			V _{BE(sat)}	Voltage = -2.0 mAa	-0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					committee	ARAHO JAVI	NB-LIAME
Current-Gain — Bandwidth Product $(I_C = -10 \text{ mAdc}, V_{CE} = -20 \text{ Vdc}, f$	= 20 MHz)			fT ts MHat	tour 50 His	in — G undse Nichtage Ver	MHz
Output Capacitance (VCB = -20 Vdc, IE = 0, f = 1.0 MH	lz)			C _{obo}	0.1 = 1.0 =	6.0	pF

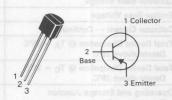
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-300	Vdc
Collector-Base Voltage	VCBO	-300	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current — Continuous	lc	-500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	O° E

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

PBF493R, RS

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

PNP SILICON

Refer to MPSA42 for graphs.

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS			ACTERISTICS	RAHO THO
Collector-Emitter Breakdown Voltage(2) (I _C = -1.0 mAdc, I _B = 0)	V(BR)CEO	-300	mitte-Break I,0 mAde, (g	Vdc
Collector-Base Breakdown Voltage (IC = -10μ Adc, IE = 0)	V(BR)CBO	-300	ass Deside 10 µAds, Ig	Vdc
Emitter-Base Breakdown Voltage ($I_E = -100 \mu Adc, I_C = 0$)	V(BR)EBO	-5.0	se Bro <u>wl</u> cdowi 100 jukata, Ig	Vdc
Collector Cutoff Current (V _{CB} = -200 Vdc, I _E = 0)	ICBO	(i) =	-0.25	μAdc
Emitter Cutoff Current (VEB = -3.0 V)	IEBO	-	-20	nAdc
Collector Cutoff Current (VCE = -10 Vdc)	ICEO	-	-250	nAdc
ON CHARACTERISTICS		()	CTEMETICS!	ON CHARA
DC Current Gain	hFE to say I IIA		Geln 0.3 milete, Vg 1.0 milete, Vg 30 milete, Vg	
Collector-Emitter Saturation Voltage (I _C = -20 mAdc, I _B = -2.0 mAdc)	VCE(sat)		-0.5	
Base-Emitter Saturation Voltage (IC = -20 mAdc, I _B = -2.0 mAdc)	V _{BE} (sat)		-0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS		CLEMBLICS	BRAIL CHARA	113-TTYME
Current-Gain — Bandwidth Product ($I_C = -10 \text{ mAdc}$, $V_{CE} = -20 \text{ Vdc}$, $f = 20 \text{ MHz}$)	(sHM os =)	50	in — A mdwi 10 mAda, Vg	MHz
Output Capacitance (V _{CB} = -20 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	0.1 = 1.0 =	6.0	pF 0

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	VCBO	75	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	lc	600	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +150	°C

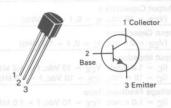
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	R_{θ} JC	83.3	°C/W

P2N2222A

25222M2

CASE 29-04, STYLE 17 TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPS2222 for graphs.

Gb Characteristic	Symbol	Min an	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0)	V(BR)CEO	40	neiro <u>a</u> tah nVi	Vdc
Collector-Base Breakdown Voltage (IC = 10 μ Adc, I _E = 0)	V(BR)CBO	75	- 1c	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	V(BR)EBO	6.0	181 =	Vdc
Collector Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc)	ICEX		10	nAdc
Collector Cutoff Current $(V_{CB} = 60 \text{ Vdc}, I_E = 0)$ $(V_{CB} = 60 \text{ Vdc}, I_E = 0, T_A = 150^{\circ}\text{C})$	ICBO	=	0.01 10	μAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0)	IEBO		10	nAdc
Collector Cutoff Current (VCE = 10 V) STIUDBIG TEST TWO LAVIDES BALLY	ICEO	_	10	nAdc
Base Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc)	IBEX	MAG 1 3 1 3 1	20	nAdc
ON CHARACTERISTICS	100.0	CYCLE = 23	5	V BIH
DC Current Gain (IC = 0.1 mAdc, V _{CE} = 10 Vdc) (IC = 1.0 mAdc, V _{CE} = 10 Vdc) (IC = 10 mAdc, V _{CE} = 10 Vdc) (IC = 10 mAdc, V _{CE} = 10 Vdc, T _A = -55°C) (IC = 150 mAdc, V _{CE} = 10 Vdc)(1) (IC = 150 mAdc, V _{CE} = 10 Vdc)(1) (IC = 500 mAdc, V _{CE} = 10 Vdc)(1)	hFE	35 50 75 35 100 50 40	300	V S-
Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc)	V _{CE(sat)}	_	0.3 1.0	Vdc
Base-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc)	V _{BE} (sat)	0.6	1.2 2.0	Vdc

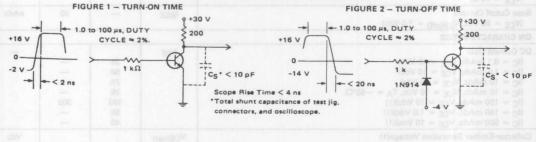
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS	rinti	Value	todiny8		dulin9	
Current Gain — Bandwidth Product(2) (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	, ahV	40	DEDIT	300	apsi to V rat	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	bly	0.8	C _{obo}	-	8.0	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	bbAm Wat	625	Cibo	Jour TA = 25%	25	pF
Input Impedance (I _C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	artsW artsW 370Vm	5.0 1.5 12	h _{ie}	2.0 0.25	8.0 1.25	kΩ
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	2/	981 + ot 88-	h _{re}	noite	8.0 4.0	X10-4
Small-Signal Current Gain (IC = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (IC = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)			h _{fe}	50 75	300 375	emal Resis
Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	ANGO	6,88	h _{oe}	5.0 25	35 200	μmhos
Collector Base Time Constant (I _E = 20 mAdc, V _{CB} = 20 Vdc, f = 31.8 MHz)		otherwise neted.	rb'C _C	RISTICS (TA	150	ps
Noise Figure (I _C = 100 μ Adc, V _{CE} = 10 Vdc, R _S = 1.0 k Ω , f = 1.0 kHz)			NF	— Cher	4.0	dB
SWITCHING CHARACTERISTICS				anatleV n	surchola and ann	lautor-Emile
Delay Time (V _{CC} = 30 Vdc, V _{BE(off)} = -	2.0 V.		td	_	10	ns
TOC OF THE (OII)			- u			-

Delay Time	$(V_{CC} = 30 \text{ Vdc}, V_{BE(off)} = -2.0 \text{ V},$	td	_	10	m of ns of
Rise Time	I _C = 150 mAdc, I _{B1} = 15 mAdc) (Figure 1)	t _r	e in stlaV	25	ns ns
Storage Time	(V _{CC} = 30 Vdc, I _C = 150 mAdc,	t _S		225	ns
Fall Time	I _{B1} = I _{B2} = 15 mAdc) (Figure 2)	tf	eliano	60	ns

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%. (2) f_T is defined as the frequency at which lh_{fe}l extrapolates to unity.

SWITCHING TIME EQUIVALENT TEST CIRCUITS



Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-60	Vdc
Collector-Base Voltage	VCBO	-60	Vdc
Emitter-Base Voltage	V _{EBO}	-5.0	Vdc
Collector Current — Continuous	IC IC	-600	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	625 5.0	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	P _D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

THE THINK OF THE OTHER OF THE			12
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

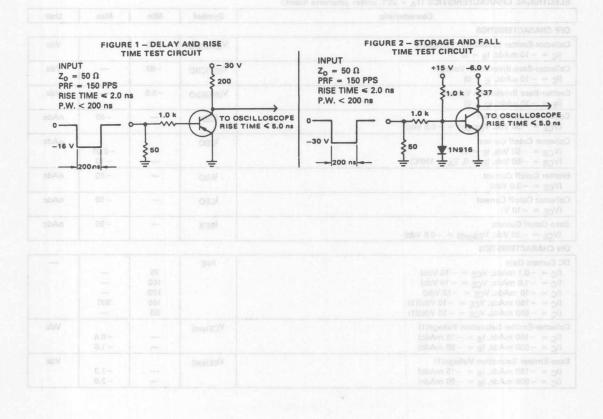
P2N2907A CASE 29-04, STYLE 17 TO-92 (TO-226AA) CASE 29-04, STYLE 17 TO-92 (TO-226AA) AMPLIFIER TRANSISTOR PNP SILICON

Refer to MPS2907 for graphs.

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (IC = -10 mAdc, IB = 0)	V _(BR) CEO	MAJ-60		Vdc
Collector-Base Breakdown Voltage (IC = -10 µAdc, IE = 0)	V _(BR) CBO	-60	80 DB	Vdc
Emitter-Base Breakdown Voltage (IE = -10 µAdc, IC = 0)	V _{(BR)EBO}	-5.0	71ME = 2.0 ms < 200 no	Vdc
Collector Cutoff Current (V _{CE} = -30 Vdc, V _{EB(off)} = -0.5 Vdc)		10.5	-50	nAdc
Collector Cutoff Current $(V_{CB} = -50 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = -50 \text{ Vdc}, I_{E} = 0, T_{A} = 150^{\circ}\text{C})$	ICBO	200	- 0.01 - 10	μAdc
Emitter Cutoff Current (V _{EB} = -3.0 Vdc)	IEBO	_	-10	nAdc
Collector Cutoff Current $(V_{CE} = -10 \text{ V})$	ICEO	_	-10	nAdc
Base Cutoff Current $(V_{CE} = -30 \text{ Vdc}, V_{EB\{off\}} = -0.5 \text{ Vdc})$	IBEX	_	-50	nAdc
ON CHARACTERISTICS				
DC Current Gain $ \begin{aligned} &(I_C = -0.1 \text{ mAdc, } V_{CE} = -10 \text{ Vdc}) \\ &(I_C = -1.0 \text{ mAdc, } V_{CE} = -10 \text{ Vdc}) \\ &(I_C = -10 \text{ mAdc, } V_{CE} = -10 \text{ Vdc}) \\ &(I_C = -150 \text{ mAdc, } V_{CE} = -10 \text{ Vdc}) \\ &(I_C = -500 \text{ mAdc, } V_{CE} = -10 \text{ Vdc})(1) \end{aligned} $	hFE	75 100 100 100 50		_
Collector-Emitter Saturation Voltage(1) $(I_C = -150 \text{ mAdc}, I_B = -15 \text{ mAdc})$ $(I_C = -500 \text{ mAdc}, I_B = -50 \text{ mAdc})$	VCE(sat)	_	- 0.4 - 1.6	Vdc
Base-Emitter Saturation Voltage(1) $ \begin{pmatrix} I_C = -150 \text{ mAdc}, I_B = -15 \text{ mAdc} \\ I_C = -500 \text{ mAdc}, I_B = -50 \text{ mAdc} \end{pmatrix} $	V _{BE(sat)}	_	-1.3 -2.6	Vdc

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

	Characteristic			Symbol	Min	Max	Unit
SMALL-SIGNAL C	HARACTERISTICS	201	andat/	Indiana di			areas.
	andwidth Product (1), (2) c, $V_{CE} = -20 \text{ Vdc}$, $f = 100 \text{ MHz}$)	sby	08 -	OBOVÍT	200	ogarloV ratt	MHz
Output Capacitano	e	nBV	00-	Cobo	_	8.0	pF
$(V_{CB} = -10 \text{ Vd})$	c, I _E = 0, f = 1.0 MHz)	obV -	-5.0	D83V		Voltage	tter-Base
Input Capacitance				Cibo	9000	30	o pF
$(V_{EB} = -2.0 \text{ Vol})$	ic, I _C = 0, f = 1.0 MHz)	Mins	202	20	THE - AT	O moitenbelo	enlus(L)
SWITCHING CHAP	ACTERISTICS	DoMes.	8.0			ve 25°C	oda eren
Turn-On Time		Wetts		ton	0765-017	50	ns
Delay Time	$V_{CC} = -30 \text{ Vdc}, I_{C} = -150 \text{ r}$ $I_{B1} = -15 \text{ mAdc}) \text{ (Figures 1 a)}$			t _d		10	ns
Rise Time	IB1 = 13 IIIAuc/ (Figures 1 al	110 3/		tr	nonon	40	ns
Turn-Off Time				toff	_	110	ns
Storage Time	$(V_{CC} = -6.0 \text{ Vdc}, I_{C} = -150 \text{ mAdc}, I_{B1} = I_{B2} = -15 \text{ mAdc (Figure 2)}$			t _S	EDITE	80	ns
Fall Time	.BI .BZ IS IIIAde (Figure	IIIIA		tf	_	30	ns



NPN Silicon Planar Epitaxial Transistor

- This NPN Silicon Epitaxial transistor is designed for use in industrial and consumer applications. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- High Current: 2.0 Amp
- The SOT-223 package can be soldered using wave or reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
 Use PZT651T1 to order the 7 inch/1000 unit reel.
 Use PZT651T3 to order the 13 inch/4000 unit reel.

PNP Complement is PZT751T1



EMITTER 3

PZT651T1

Motorola Preferred Device

SOT-223 PACKAGE HIGH CURRENT NPN SILICON TRANSISTOR SURFACE MOUNT



CASE 318E-04, STYLE 1 TO-261AA

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	60 001 = 8	Vdc
Collector-Base Voltage	VCBO	80 rubiwb	Vdc Vdc
Emitter-Base Voltage	V _{EBO}	5.0	Vdc
Collector Current	lc	2.0	Adc
Total Power Dissipation @ T _A = 25°C ⁽¹⁾ Derate above 25°C	PD	0.8 6.4	Watts mW/°C
Storage Temperature Range	T _{stg}	-65 to 150	°C
Junction Temperature	TJ	150	°C

DEVICE MARKING

651

THERMAL CHARACTERISTICS

Thermal Resistance from Junction-to-Ambient in Free Air	R ₀ JA	156	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	TL	260 10	°C Sec

^{1.} Device mounted on a FR-4 glass epoxy printed circuit board using minimum recommended footprint.

Preferred devices are Motorola recommended choices for future use and best overall value.

PZT651T1

Characteristics	Symbol	Min	Max	Unit
FF CHARACTERISTICS			THE REAL PROPERTY.	
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	V _(BR) CEO	60	SiHee	Vdc
Collector-Emitter Breakdown Voltage (I _C = 100 µAdc, I _E = 0)	V _(BR) CBO	80	I IEIA	Vdc
Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0)	V _{(BR)EBO}	5.0	i anousoilge medium pov	Vdc
Base-Emitter Cutoff Current (VEB = 4.0 Vdc)	IEBO	shine and non-	0.1	μAdc
Collector-Base Cutoff Current (V _{CB} = 80 Vdc, I _E = 0)	ІСВО	om level aeru i vlaual inspa	100	nAdc
ON CHARACTERISTICS (2)	soldering, elimina	tress during a	sorb thennals	da ebas
DC Current Gain (I _C = 50 mAdc, V _{CE} = 2.0 Vdc) (I _C = 500 mAdc, V _{CE} = 2.0 Vdc) (I _C = 1.0 Adc, V _{CE} = 2.0 Vdc) (I _C = 2.0 Adc, V _{CE} = 2.0 Vdc) (I _C = 2.0 Adc, V _{CE} = 2.0 Vdc)	hFE Jose fina 0001\d		11 12-im de 216 11 12-im Te 2165-1 1 to 1 2765-1 1 to 1 2765-1 3 to 1 2765-1 3 to 1 2765-1 3 to 2 2765-1 3 to 3 2765-1 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	A <u>rn</u> ege Vse P Use P Use P Patic Coa
Collector-Emitter Saturation Voltages ($I_C = 2.0$ Adc, $I_B = 200$ mAdc) ($I_C = 1.0$ Adc, $I_B = 100$ mAdc)	VCE(sat)	=	0.5 0.3	Vdc
Base-Emitter Voltages ($I_C = 1.0$ Adc, $V_{CE} = 2.0$ Vdc)	V _{BE} (on)	selnu Oraș = ç	1.0	Vdc
Base-Emitter Saturation Voltage (I _C = 1.0 Adc, I _B = 100 mAdc)	VBE(sat)	117625	1.2 egistion rether	Vdc
Current-Gain-Bandwidth (I _C = 50 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz)	fT	75	ase Vetage	MHz

^{2.} Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle = 2.0%.

PNP Silicon Planar Epitaxial Transistor

This PNP Silicon Epitaxial transistor is designed for use in industrial and consumer applications. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- · High Current: 2.0 Amp
- The SOT-223 Package can be soldered using wave or reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die

Available in 12 mm Tape and Reel
 Use PZT751T1 to order the 7 inch/1000 unit reel.
 Use PZT751T3 to order the 13 inch/4000 unit reel.

NPN Complement is PZT651T1

BASE 1

EMITTER 3

PZT751T1

Motorola Preferred Device

SOT-223 PACKAGE HIGH CURRENT PNP SILICON TRANSISTOR SURFACE MOUNT



CASE 318E-04, STYLE 1 TO-261AA

MAXIMUM RATINGS (TC = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage (15e) Bel V	VCEO	60	Vdc
Collector-Base Voltage	V _{CBO}	80	Vdc
Emitter-Base Voltage	V _{EBO}	= 1,00 5.0 = 50	Vdc
Collector Current	and sign size of	O au 2.0 doing	Adc
Total Power Dissipation @ T _A = 25°C(1) Derate above 25°C	PD	0.8 6.4	Watts mW/°C
Storage Temperature Range	T _{stg}	-65 to 150	°C
Junction Temperature	TJ	150	°C

DEVICE MARKING

ZT751

THERMAL CHARACTERISTICS

Thermal Resistance from Junction-to-Ambient in Free Air	R ₀ JA	156	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	TL	260 10	°C Sec

^{1.} Device mounted on a FR-4 glass epoxy printed circuit board using minimum recommended footprint.

Preferred devices are Motorola recommended choices for future use and best overall value.

Characteristics	Symbol	Min	Max	Unit		
FF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	V(BR)CEO	60	OCZNI T Lesiv	Vdc		
Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	V(BR)CBO	80	Slices Epise	Vdc		
Emitter-Base Breakdown Voltage (I _C = 10 μAdc, I _C = 0)	V(BR)EBO	5.0	alcat <u>la</u> ns. The nedium powe	Vdc		
Base-Emitter Cutoff Current (VEB = 4.0 Vdc)	IEBO	ebles ad nac	0.1	μAdc		
Collector-Base Cutoff Current (V _{CB} = 80 Vdc, I _E = 0)	bernot erff. ship hadde to not	ras lo v el mou vieue) insped	100	nAdc		
N CHARACTERISTICS (2)	to validiason sitt grasinimine genteble	ser count se	NO BUTTON BE	Bads abso		
DC Current Gain ($I_C = 50 \text{ mAdc}, V_{CE} = 2.0 \text{ Vdc}$) ($I_C = 500 \text{ mAdc}, V_{CE} = 2.0 \text{ Vdc}$) ($I_C = 1.0 \text{ Adc}, V_{CE} = 2.0 \text{ Vdc}$) ($I_C = 2.0 \text{ Adc}, V_{CE} = 2.0 \text{ Vdc}$)	hFE Jean flow 000 th Jean flow 00014ri	/5	n 12 mm Tage T751_T1 to un T751_E3 to on olement is P.2	Vallable II Use PE Use PE IPN Con		
Collector-Emitter Saturation Voltages ($I_C = 2.0$ Adc, $I_B = 200$ mAdc) ($I_C = 1.0$ Adc, $I_B = 100$ mAdc)	VCE(sat)	=	0.5 0.3	Vdc		
Base-Emitter Voltages (I _C = 1.0 Adc, V _{CE} = 2.0 Vdc)	VBE(on)	skelnu-9°ës = Ratina	1.0 TA	Vdc		
Base-Emitter Saturation Voltage (I _C = 1.0 Adc, I _B = 100 mAdc)	VBE(sat)	-	1.2	Vdc		
Current-Gain-Bandwidth (I _C = 50 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz)	f _T	75	egalov si	MHz		
. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%			iner	nuO ramello		

NPN Silicon Planar Epitaxial Transistor

This NPN Silicon Epitaxial transistor is designed for use in linear and switching applications. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- PNP Complement is PZT2907AT1
- The SOT-223 package can be soldered using wave or reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die.
- Available in 12 mm tape and reel
 Use PZT2222AT1 to order the 7 inch/1000 unit reel.
 Use PZT2222AT3 to order the 13 inch/4000 unit reel.





Motorola Preferred Device

SOT-223 PACKAGE NPN SILICON TRANSISTOR SURFACE MOUNT



CASE 318E-04, STYLE 1 TO-261AA

MAXIMUM RATINGS

Rating	Symbol	Value O Immuo	Unit				
Collector-Emitter Voltage	VCEO	40	Vdc				
Collector-Base Voltage	VCBO	75	Vdc				
Emitter-Base Voltage (Open Collector)	VEBO	Vulc. 10 = 1 0.6 Adc. 1 = 1.0	Vdc				
Collector Current	I _C (SH)	600	mAdc				
Total Power Dissipation up to T _A = 25°C(1)	PD	1.5 01 = 30 VI	Watts				
Storage Temperature Range	T _{stg}	- 65 to +150	°C				
Junction Temperature	TJ	hubon 150 whose - n	°C				

THERMAL CHARACTERISTICS

Thermal Resistance from Junction to Ambient	ReJA	83.3	°C/W
Lead Temperature for Soldering, 0.0625" from case	TL	260	°C
Time in Solder Bath		10	Sec

DEVICE MARKING

P1F

Characteristic	Symbol	MIN	Max	Unit
OFF CHARACTERISTICS				9(11) (89)
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	V(BR)CEO	40	_	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu Adc, I_E = 0$)	V(BR)CBO	75	_	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V(BR)EBO	6.0	_	Vdc
Base-Emitter Cutoff Current ($V_{CE} = 60 \text{ Vdc}$, $V_{BE} = -3.0 \text{ Vdc}$)	IBEX	_	20	nAdc
Collector-Emitter Cutoff Current ($V_{CE} = 60 \text{ Vdc}$, $V_{BE} = -3.0 \text{ Vdc}$)	ICEX	_	10	nAdc
Emitter-Base Cutoff Current (V _{EB} = 3.0 Vdc, I _C = 0)	IEBO	_	100	nAdc

Device mounted on an epoxy printed circuit board 1.575 inches x 1.575 inches x 0.059 inches; mounting pad for the collector lead min. 0.93 inches².
 Preferred devices are Motorola recommended choices for future use and best overall value.

PZT2222AT1

		Chara	cteristic		Symbol	Min	Max	Unit
FF CHARACTER	RISTICS (continued)						
Collector-Base C	utoff Curre		Vdc, I _E = 0) 60 Vdc, I _E = 0, T _A =	125°C)	ICBO	4 EO	10 10	nAdc μAdc
N CHARACTER	ISTICS				Wididl	11611	IDIAE	FILE
DC Current Gain (IC = 0.1 mAdd (IC = 1.0 mAdd (IC = 10 mAdd (IC = 150 mAdd (IC = 150 mAdd (IC = 150 mAdd (IC = 500 mAdd	c, VCE = 1 c, VCE = 1 c, VCE = 1 c, VCE = 1 dc, VCE = dc, VCE =	0 Vdc) 0 Vdc) 0 Vdc, T _A = - 10 Vdc) 1.0 Vdc)	ai dolriw 55°C)	signed for use in line SOT-223 package oatlons. wave or reflow. sutting in improved the	i is housed in the second	35 50 70 35 100 50 40	300	Triis N witching ssigned PNP C The SC SOT-2
Collector-Emitter (I _C = 150 mAd (I _C = 500 mAd	$lc, l_B = 15$	mAdc)	To while	eliminating the possif	VCE(sat)	ib easite in	0.3 1.0	Vdc
Base-Emitter Saturation Voltages (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc)						0.6	1.2 2.0	Vdc
Input Impedance (V _{CE} = 10 Vdc, I _C = 1.0 mAdc, f = 1.0 kHz) (V _{CE} = 10 Vdc, I _C = 10 mAdc, f = 1.0 kHz)					h _{ie}	2.0 0.25	8.0 1.25	kΩ
Voltage Feedbac (VCE = 10 Vdc (VCE = 10 Vdc	c, $I_C = 1.0$				h _{re}	=	8.0x10 ⁻⁴ 4.0x10 ⁻⁴	UMIXA
Small-Signal Cur (V _{CE} = 10 Vd (V _{CE} = 10 Vd	c, $I_C = 1.0$	mAdc, f = 1.0			h _{fe}	50 75	300 375	Collecto
Output Admittan (VCE = 10 Vd (VCE = 10 Vd	c, $I_C = 1.0$				h _{oe}	5.0 25	35 200	μmho
Noise Figure (Vo	DE = 10 Vo	dc, I _C = 100 μ	Adc, f = 1.0 kHz)		Fr)ores	= AT OLDU	4.0	dB
YNAMIC CHAR			Term			3000	E enutariourial	Storage
Current-Gain — (I _C = 20 mAdd) MHz)		fT	300	Tamp — abure	MHz
Output Capacita	nce (V _{CB}	= 10 Vdc, IE :	= 0, f = 1.0 MHz)		C _C		8.0	pF
Input Capacitano	ce (V _{EB} =	0.5 Vdc, I _C =	0, f = 1.0 MHz)		Ce	O solvátila	25	pF
SWITCHING TIM	ES (TA =	25°C)	4		110011 30000		Solder Bails	u amil'
Delay Time		= 30 Vdc, I _C			t _d	_	10	ns
Rise Time	IB(on)		VEB(off) = 0.5 Vdc)		tr	_	25	PIF
Storage Time	(V _C C	= 30 Vdc, I _C	= 150 mAdc,	(belon salwierto zaelin	t _s	CIERISI	225	ns
Fall Time		= IB(off) = 15			tf	10	60	
			1			200	THE LOVE	100



Figure 1. Input Waveform and Test Circuit for Determining Delay Time and Rise Time

V = -0.5 V to +9.9 V, V CC = +30 V, R1 = 619 Ω , R2 = 200 Ω

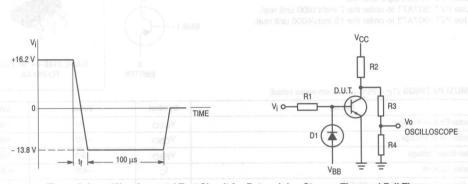
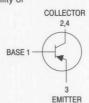


Figure 2. Input Waveform and Test Circuit for Determining Storage Time and Fall Time

PNP Silicon Epitaxial Transistor

This PNP Silicon Epitaxial transistor is designed for use in linear and switching applications. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- NPN Complement is PZT2222AT1
- The SOT-223 package can be soldered using wave or reflow
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 12 mm tape and reel
 Use PZT2907AT1 to order the 7 inch/1000 unit reel.
 Use PZT2907AT3 to order the 13 inch/4000 unit reel.



PZT2907AT1

Motorola Preferred Device

SOT-223 PACKAGE PNP SILICON TRANSISTOR SURFACE MOUNT



CASE 318E-04, STYLE 1 TO-261AA

MAXIMUM RATINGS (TC = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-60	Vdc
Collector-Base Voltage	VCBO	-60	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current	Ic	-600	mAdc
Total Power Dissipation @ T _A = 25°C ⁽¹⁾ Derate above 25°C	DPD moley	1.5	Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{stg}	-65 to 150	°C

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)	R ₀ JA	83.3	°C/W
Lead Temperature for Soldering, 0.0625" from case	TL	260	°C
Time in Solder Bath		10	Sec

DEVICE MARKING

P2F

Characteristic	Symbol	Min	Тур	Max	Unit
DFF CHARACTERISTICS					
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc$, $I_E = 0$)	V(BR)CBO	-60	_	_	Vdc
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	V(BR)CEO	-60	-	- 1	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc$, $I_C = 0$)	V(BR)EBO	-5.0	-	-	Vdc
Collector-Base Cutoff Current ($V_{CB} = -50 \text{ Vdc}$, $I_{E} = 0$)	ІСВО	-	_	-10	nAdo
Collector-Emitter Cutoff Current (V _{CE} = -30 Vdc, V _{BE} = 0.5 Vdc)	ICEX	_	-	-50	nAdc
Base-Emitter Cutoff Current (V _{CE} = -30 Vdc, V _{BE} = -0.5 Vdc)	IBEX	_	_	-50	nAdc

^{1.} Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 sq. in. **Preferred** devices are Motorola recommended choices for future use and best overall value.

	Symbol	Min	Тур	Max	Unit	
N CHARACTERISTIC	S(2) 100 100 100 100 100 100 100 100 100 10					1000
DC Current Gain $ \begin{aligned} &(I_C = -0.1 \text{ mAdc, } V_{CE} = -10 \text{ Vdc}) \\ &(I_C = -1.0 \text{ mAdc, } V_{CE} = -10 \text{ Vdc}) \\ &(I_C = -10 \text{ mAdc, } V_{CE} = -10 \text{ Vdc}) \\ &(I_C = -150 \text{ mAdc, } V_{CE} = -10 \text{ Vdc}) \\ &(I_C = -500 \text{ mAdc, } V_{CE} = -10 \text{ Vdc}) \end{aligned} $			75 100 100 100 50		300	- 001
Collector-Emitter Saturation Voltages (I _C = -150 mAdc, I _B = -15 mAdc) (I _C = -500 mAdc, I _B = -50 mAdc)			=	D°88	-0.4 -1.6	Vdc
Base-Emitter Saturation Voltages (I _C = -150 mAdc, I _B = -15 mAdc) (I _C = -500 mAdc, I _B = -50 mAdc)			=	=	-1.3 -2.6	Vdc
YNAMIC CHARACTE	RISTICS	007-	UI-	0.1		1.0-
Current-Gain — Bandwidth Product (I _C = -50 mAdc, V _{CE} = -20 Vdc, f = 100 MHz)		fT	200	_	_	MHz
Output Capacitance (\	V _{CB} = -10 Vdc, I _E = 0, f = 1.0 MHz)	C _C	gu <u>0</u> u .	- เป <u>ตต</u> า	8.0	pF
Input Capacitance (VE	EB = -2.0 Vdc, I _C = 0, f = 1.0 MHz)	Ce	_	—	30	pF
WITCHING TIMES		morn	TUTT			70.1-
Turn-On Time	20 20	ton	111-1		45	ns
Delay Time	(V _{CC} = -30 Vdc, I _C = -150 mAdc, I _{R1} = -15 mAdc)	td	O- 92 (BB)	19V —	10	8.0-
Rise Time	- 'BI - 10	t _r	-		40	
Turn-Off Time		toff	(10) (10) (3k	-	100	ns
Storage Time	(V _{CC} = -6.0 Vdc, I _C = -150 mAdc, I _{B1} = I _{B2} = -15 mAdc)	t _S	-		80	
Fall Time	181 - 182 - 10 11/100)	tf			30	10.0-

Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

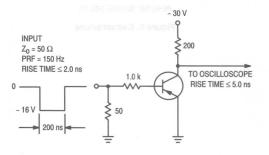


Figure 1. Delay and Rise Time Test Circuit

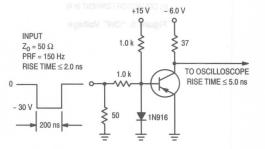
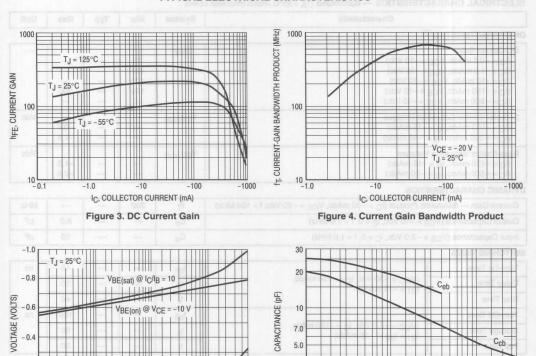


Figure 2. Storage and Fall Time Test Circuit

TYPICAL ELECTRICAL CHARACTERISTICS



3.0

VCE(sat) @ Ic/l_B = 10 -0.1 -0.2 -0.5 -1.0 -2.0 -5.0 -10 -20 -50 -100 -200 -500

REVERSE VOLTAGE (VOLTS)

Figure 6. Capacitances

-0.1 -0.2 -0.3 -0.5 -0.7 -1.0 -2.0 -3.0 -5.0 -7.0 -10 -20 -30

-0.2

NPN Small-Signal Darlington Transistor

This NPN small signal darlington transistor is designed for use in switching applications, such as print hammer, relay, solenoid and lamp drivers. The device is housed in the SOT-223 package, which is designed for medium power surface mount applications.

- High f_T: 125 MHz Minimum
- · The SOT-223 Package can be soldered using wave or reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die.
- Available in 12 mm Tape and Reel
 Use PZTA14T1 to order the 7 inch/1000 unit reel
 Use PZTA14T3 to order the 13 inch/4000 unit reel
- The PNP Complement is PZTA64T1

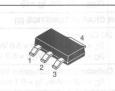


EMITTER 3

PZTA14T1

Motorola Preferred Device

MEDIUM POWER NPN SILICON DARLINGTON TRANSISTOR SURFACE MOUNT



CASE 318E-04, STYLE 1 TO-261AA

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCES	30	Vdc
Collector-Emitter Voltage	VCEO	30	Vdc
Emitter-Base Voltage	V _{EBO}	10	Vdc
Collector Current	IC	300	mAdc
Total Power Dissipation @ T _A = 25°C(1)	PD	1.5	Watts
Operating and Storage Temperature Range	T _J , T _{stg}	-65 to 150	°C

DEVICE MARKING

P1N

THERMAL CHARACTERISTICS

Thermal Resistance Junction-to-Ambient (surface mounted)	R _θ JA	83.3	°C/W
Maximum Temperature for Soldering Purposes	TL	260	°C
Time in Solder Bath		10	Sec

^{1.} Device mounted on a FR-4 glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.0625 in.; mounting pad for the collector lead = 0.93 sq. in.

Preferred devices are Motorola recommended choices for future use and best overall value.

	Characteristic	s	Symbol	Min	Тур	Max	Unit
OFF CHARACTER	RISTICS						
Collector-Base B (I _C = 100 μAdd	Breakdown Voltage c, I _E = 0)		V(BR)CBO	30	NOIS.	IBHI6	Vdc
	Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, I _B = 0)		V _(BR) CES	30	a kee y a	tanoir lisma	Vdc
	Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0)		(511)250	nelo 10	nt hammer. 17-223 packs	suc = as pil sad in the SC	Vdc
	Collector-Base Cutoff Current (V _{CB} = 30 Vdc, I _E = 0)		Ісво		mums	0.1 A	μAdc
Emitter-Base Cutoff Current (VEB = 10 Vdc, I _C = 0)		IEBO	ered uzing w Lucen, resul	can <u>he</u> solde ures level mo	220 1.0 dags	μAdc	
ON CHARACTER	ISTICS (2)	be	red joints. The form	pblee to neito	equal musik	n, and allows	enauenea
DC Current Gain (I _C = 10 mAdd (I _C = 100 mAdd		S AGTGRUED	hFE	10,000 20,000	leaF_bris e	othe die. in 12 <u>.e</u> m Tac	damage t Available
	r Saturation Voltage dc, I _B = 0.1 mAdc)	30.48	VCE(sat)	:h/4000 unit	re El enine de la pri	1.5	Vdc
Base-Emitter On (I _C = 100 mAc	Voltage dc, V _{CE} = 5.0 Vdc)	earma .	V _{BE(on)} — —		2.0	Vdc	
DYNAMIC CHARA	ACTERISTICS		(ba)	on ealwisertto	= 25°C unluse	ATINGS (TO	NUMBER
	Bandwidth Product c, V _{CE} = 5.0 Vdc)	Symbal	fT	125	ottofi —	and the continues	MHz
. Pulse Test: Puls	se Width ≤ 300 μs, Du					nositov remi	- Australio
							Vaximum Te Sime in Sold

TYPICAL ELECTRICAL CHARACTERISTICS

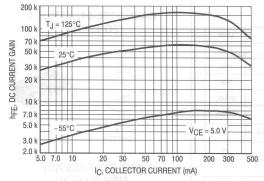
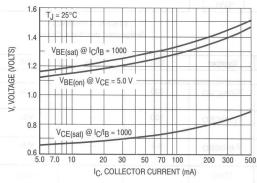


Figure 1. DC Current Gain

Figure 2. High Frequency Current Gain



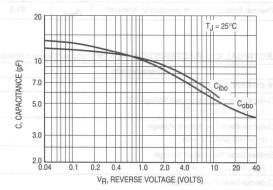
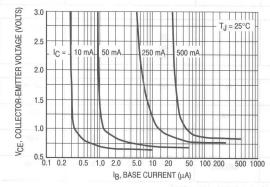


Figure 3. "On" Voltages

Figure 4. Capacitance



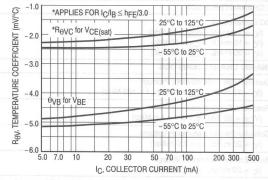


Figure 5. Collector Saturation Region

Figure 6. Temperature Coefficients

Rating	Symbol	Value	Unit
Collector-Emitter Voltage (Open Base)	VCEO	300	Vdc
Collector-Base Voltage (Open Emitter)	VCBO	300	Vdc
Emitter-Base Voltage (Open Collector)	VEBO	6.0	Vdc
Collector Current (DC)	IC	500	mAdo
Total Power Dissipation up to T _A = 25°C*	PD*	1.5	Watts
Storage Temperature Range	T _{stg}	- 65 to +150	°C
Junction Temperature	TJ	150	°C

DEVICE MARKING

P1D

THERMAL CHARACTERISTICS

1				
	Thermal Resistance from Junction to Ambient*	ReJA	83.3	°C/W

PZTA42T1*

CASE 318E-04, STYLE 1 (TO-261AA)





SOT-223 PACKAGE NPN SILICON HIGH VOLTAGE TRANSISTOR SURFACE MOUNT

*This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
FF CHARACTERISTICS	8	LIELE'vi	A service of the service	
Collector-Emitter Breakdown Voltage (1) (I _C = 1.0 mAdc, I _B = 0)	V _(BR) CEO	300		Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	V(BR)CBO	300	If a stol @ susso	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)	V(BR)EBO	6.0	F 7 11	Vdc
Collector-Base Cutoff Current ($V_{CB} = 200 \text{ Vdc}, I_E = 0$)	ICBO	An TREREUM (NAME)	0.1	μAdc
Emitter-Base Cutoff Current (V _{BE} = 6.0 Vdc, I _C = 0)	I _{EBO}		0.1	μAdc
N CHARACTERISTICS				TITLIAR.
DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc)	hFE	25 40 40	Am-06 Lam us	2.5
YNAMIC CHARACTERISTICS				20-
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	ĺΤ	50		MHz
Feedback Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 1.0 MHz)	C _{re}		3.0	pF
Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc)	VCE(sat)		0.5	Vdc
Base-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc)	V _{BE} (sat)	S.O 10 20 SO MSE CURRENT (MA)	0.9	Vdc

The vice mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 in². (1) Pulse Test Conditions, $t_p = 300 \,\mu s$, $\delta = 0.02$.

PNP Small-Signal Darlington Transistor

This PNP small-signal darlington transistor is designed for use in preamplifiers input applications or wherever it is necessary to have a high input impedance. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- High fT: 125 MHz Minimum
- The SOT-223 Package can be soldered using wave or reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 12 mm Tape and Reel
 Use PZTA64T1 to order the 7 inch/1000 unit reel.
 Use PZTA64T3 to order the 13 inch/4000 unit reel.
- NPN Complement is PZTA14T1

PZTA64T1

Motorola Preferred Device

SOT-223 PACKAGE PNP SILICON DARLINGTON TRANSISTOR SURFACE MOUNT



EMITTER 3



CASE 318E-04, STYLE 1 TO-261AA

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCES	30	Vdc
Collector-Base Voltage	V _{CBO}	30	Vdc
Emitter-Base Voltage	V _{EBO}	10	Vdc
Total Power Dissipation @ T _A = 25°C(1)	PD	1.5	Watts
Collector Current	lc	500	mAdc
Operating and Storage Temperature Range	T _J , T _{stg}	-65 to +150	°C

DEVICE MARKING

P₂V

THERMAL CHARACTERISTICS

Thermal Resistance from Junction to Ambient (surface mounted)	R ₀ JA	83.3	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	TL	260 10	°C Sec

^{1.} Device mounted on a FR-4 glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.0625 in.; mounting pad for the collector lead = 0.93 sq. in.

Preferred devices are Motorola recommended choices for future use and best overall value.

PZTA64T1

	Character	stic	Symbol	Min	Max	Unit
OFF CHARACTE	RISTICS					
Collector-Emitter	r Breakdown Voltage lc, V _{BE} = 0)		V(BR)CES	30	6-ILSIN	Vdc
Collector-Base E (I _C = 100 μA,	Breakdown Voltage	aneitiloma	V(BR)CBO	30	mihab lanola-lia	Vdc
	mitter-Base Breakdown Voltage ($I_E = 100 \mu A, I_C = 0$)		V _{(BR)EBO}	10 1 a l	s or will rever oused in the St	Vdc
	tter-Base Cutoff Current (BE = 10 Vdc, I _C = 0)		IEBO	and	0.1	μAdc
	ctor-Base Cutoff Current VCB = 30 Vdc, IE = 0)		ICBO	u bena <u>ta</u> los ed Jevel mounting	0.1	μAdc
ON CHARACTER	RISTICS (2)	Lastri	solderes jourse, the for	al inspection o	ING SHOWS VISU	conduction, s
	n c, V _{CE} = 5.0 Vdc) dc, V _{CE} = 5.0 Vdc)	COLLECTOR 2.	hFE	10,000 20,000	ie dis. 12 mm <u>T</u> ape er	danter to t
	Saturation Voltage (c, I _B = 0.1 mAdc)		VCE(sat)	he 13 moh/400	1.5	Vdc
Base-Emitter Or (VCE = 5.0 Vo	ter On-Voltage 5.0 Vdc, I _C = 100 mAdc)		V _{BE(on)}	-	2.0	Vdc
DYNAMIC CHAR	ACTERISTICS		ibalon salv	nodio sestru Of	as a on eathir	AH MUMEKA
	Bandwidth Product c, V _{CE} = 5.0 Vdc, f =	00 MHz)	fτ	125	-	MHz
	se Width ≤ 300 μs, Du				alimina a	ANTI CONTROLLER
					TRIBETOARI	

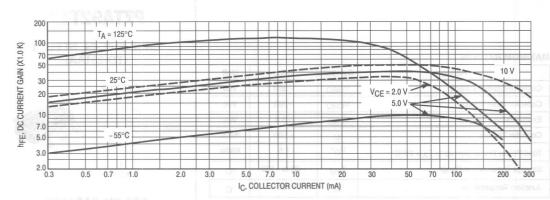


Figure 1. DC Current Gain

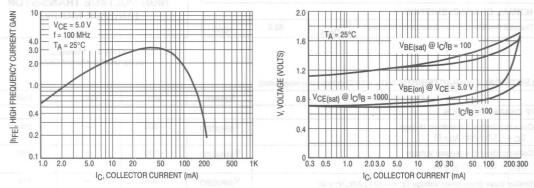


Figure 2. High Frequency Current Gain

Figure 3. "On" Voltage

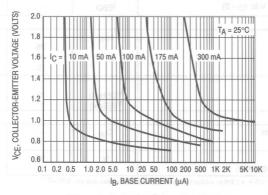


Figure 4. Collector Saturation Region

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	- 300	Vdc
Collector-Base Voltage	VCBO	- 300	Vdc
Emitter-Base Voltage	VEBO	- 5.0	Vdc
Collector Current	Ic	- 500	mAdd
Total Power Dissipation up to T _A = 25°C*	PD*	1.5	Watts
Storage Temperature Range	T _{stg}	- 65 to +150	°C
Junction Temperature	TJ	150	o∘c

DEVICE MARKING

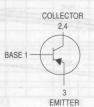
P2D

THERMAL CHARACTERISTICS

Thermal Resistance from Junction to Ambient*	ReJA	83.3	°C/W
	NOON		

PZTA92T1*

CASE 318E-04, STYLE 1 (TO-261AA)





SOT-223 PACKAGE PNP SILICON HIGH VOLTAGE TRANSISTOR SURFACE MOUNT

*This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
FF CHARACTERISTICS				4.0
Collector-Emitter Breakdown Voltage (I _C = -1.0 mAdc, I _B = 0)	V _(BR) CEO	- 300		Vdc
Collector-Base Breakdown Voltage (I _C = - 100 µAdc, I _E = 0)	V(BR)CBO	- 300	01 0.5 10	Vdc
Emitter-Base Breakdown Voltage ($I_E = -100 \mu Adc$, $I_C = 0$)	V _{(BR)EBO}	- 5.0	(388) (3)	Vdc
Collector-Base Cutoff Current (V _{CB} = - 200 Vdc, I _E = 0)	СВО	M Koulenbert	- 0.25	μAdc
Emitter-Base Cutoff Current (V _{BE} = - 3.0 Vdc, I _C = 0)	IEBO		- 0.1	μAdc
N CHARACTERISTICS	THE LIBERT			
DC Current Gain (1) $ (I_C = -1.0 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}) $ $ (I_C = -10 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}) $ $ (I_C = -30 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}) $ $ (I_C = -30 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}) $	hFE	25 40 25	_	_
Saturation Voltages $ \begin{aligned} &(I_C = -20 \text{ mAdc}, I_B = -2.0 \text{ mAdc}) \\ &(I_C = -20 \text{ mAdc}, I_B = -2.0 \text{ mAdc}) \end{aligned} $	VCE(sat) VBE(sat)		- 0.5 - 0.9	Vdc
YNAMIC CHARACTERISTICS				
Collector-Base Capacitance @ f = 1.0 MHz (V _{CB} = -20 Vdc, I _E = 0)	C _{cb}	80 8	6.0	pF
Current-Gain — Bandwidth Product (I _C = -10 mAdc, V _{CE} = -20 Vdc, f = 100 MHz)	f _T	50		MHz

^{*} Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 in².

(1) Pulse Test: Pulse Width \leq 300 $\mu s;$ Duty Cycle = 2.0%.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	- 450	Vdc
Collector-Base Voltage	V _{CBO}	- 450	Vdc
Emitter-Base Voltage	VEBO	- 5.0	Vdc
Collector Current	IC	- 500	mAdo
Total Power Dissipation up to T _A = 25°C*	PD*	1.5	Watts
Storage Temperature Range	T _{stg}	- 65 to +150	°C
Junction Temperature	TJ	150	°C

DEVICE MARKING

ZTA96

THERMAL CHARACTERISTICS

Thermal Resistance from Junction to Ambient*	R ₀ JA	83.3	°C
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PZTA96T1*

CASE 318E-04, STYLE 1 (TO-261AA)





SOT-223 PACKAGE PNP SILICON HIGH VOLTAGE TRANSISTOR SURFACE MOUNT

*This is a Motorola designated preferred device.

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = -1.0 \text{ mAdc}$, $I_B = 0$)	V(BR)CEO	- 450	_	Vdc
Collector-Emitter Breakdown Voltage (I _C = -100 μAdc, I _E = 0)	V(BR)CBO	- 450	_	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc, I_C = 0$)	V(BR)EBO	- 5.0	_	Vdc
Collector-Base Cutoff Current (V _{CB} = -400 Vdc, I _E = 0)	ICBO	_	- 0.1	μAdc
Emitter-Base Cutoff Current ($V_{BE} = -4.0 \text{ Vdc}, I_{C} = 0$)	IEBO	_	- 0.1	μAdo
N CHARACTERISTICS				
DC Current Gain (1) (I _C = -10 mAdc, V _{CE} = -10 Vdc)	hFE	50	150	_
Saturation Voltages (I _C = -20 mAdc, I _B = -2.0 mAdc) (I _C = -20 mAdc, I _B = -2.0 mAdc)	VCE(sat) VBE(sat)	-	- 0.6 - 1.0	Vdc

^{*}Device mounted on an epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 in².

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs; Duty Cycle = 2.0%.

PZTASST1*

CASE 318E-04, STYLE 1 (TO-281AA)



SOT-223 PACKAGE PNP SILICON RIGH VOLTAGE TRANSISTOR SURFACE MOUNT
 Collector Emitter Voltage
 VGBQ
 -480
 Vds

 Collector Base Voltage
 VGBQ
 -480
 Vds

 Emitter Base Voltage
 VBBQ
 -5.0
 Vds

 Collector Current
 IQ
 -500
 mAnd

 Collector Current
 IQ
 -500
 mAnd

 Total Power Classication up to TA = 25°C
 PD
 1.5
 Vwids

 Storage Temperature Group
 Tag
 -6.5 to +150
 *Q

 Junction Temperature
 Tag
 -6.5 to +150
 *Q

 CEVICE MARKING
 *Q
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 *Q

 Themsel Resistance from Junction to Ambient
 RQUA
 83.3
 *Q

*This is a Meterola designated preferred device.

V(BR)EBO		

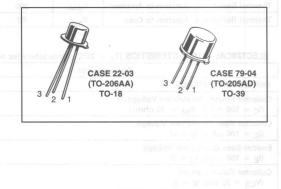
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Section 3 Metal-Can Transistors

Firsting	Symbol	Value	Unit		
Callector-Entire	oftige	VGER	60	Vdc	
Callector-Essent	age	VGRO	80	Vdc	
Entire -Essent	age	VGRO	80	Vdc	
Entire -Essent	Age	Symbol	VGRO	80	Vdc
Entire -Essent	Age	Age	Vdc		
Descript	Age	Age	Age	Age	Age
Descript	Age	Age	Age	Age	Age
Descript	Age	Age	Age	Age	Age
Descript	Age	Age	Age	Age	
Descript	Age	Age	Age	Age	
Descript	Age	Age	Age	Age	
Descript	Age	Age	Age		
Age					
Age	Age				
Age					

In Brief . . .

Motorola's metal-can transistor product offering includes: general purpose, switching, high voltage, choppers, Darlingtons, and low noise amplifiers.



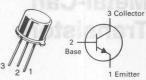
WAXIWOW NATINGS							
Rating	Symbol	Value	Unit				
Collector-Emitter Voltage	VCER	40	Vdc				
Collector-Base Voltage	VCBO	60	Vdc				
Emitter-Base Voltage	VEBO	5.0	Vdc				
Total Device Dissipation @ $T_A = 25^{\circ}C$ Derate above $25^{\circ}C$	PD	0.6 4.0	Watt mW/°C				
Total Device Dissipation @ $T_C = 25^{\circ}C$ Derate above $25^{\circ}C$	PD	2.0 13.3	Watts mW/°C				
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C				

THERMAL CHARACTERISTICS

THE MINAL OF A MANAGE MOTION							
Characteristic	Symbol	Max	Unit				
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	290	°C/W				
Thermal Resistance, Junction to Case	R_{θ} JC	88	°C/W				

2N697

CASE 79-04, STYLE 1 TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N2218A for graphs.

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I _C = 100 mAdc, R _{BE} = 10 ohms)	V(BR)CER	40		Vdc
Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0)	V(BR)CBO	60		Vdc
Emitter-Base Breakdown Voltage (IE = 100 μ Adc, IC = 0)	V(BR)EBO	5.0	-	Vdc
Collector Cutoff Current $(V_{CB} = 30 \text{ Vdc}, I_E = 0)$ $(V_{CB} = 30 \text{ Vdc}, I_E = 0, T_A = 150^{\circ}\text{C})$	ІСВО	Ξ	1.0 100	μAdc
ON CHARACTERISTICS				
DC Current Gain(1) (I _C = 150 mAdc, V _{CE} = 10 Vdc)	hFE	40	120	-
Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc)	VCE(sat)	-	1.5	Vdc
Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc)	V _{BE} (sat)	-	1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C _{obo}	-	35	pF
Small-Signal Current Gain (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz)	h _{fe}	2.5	_	MHz

⁽¹⁾ Pulse Test: Pulse Length \leq 300 μ s, Duty Cycle \leq 2.0%.

	Rating	Symbol	2N718A 2N956	2N1711	Unit
Collector-Er	nitter Voltage	VCER	5	0	Vdc
Collector-Base Voltage		VCBO	75		Vdc
Emitter-Base Voltage		VEBO	7.0		Vdc
Total Device Derate ab	e Dissipation @ $T_A = 25^{\circ}C$ ove $25^{\circ}C$	PD	500 2.86	800 4.57	mW mW/°C
Total Device Derate ab	e Dissipation @ T _C = 25°C love 25°C	PD	1.8 10.3	3.0 17.15	Watts mW/°C
	nd Storage Junction ure Range	T _J , T _{stg}	-65 to	+200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	2N718A 2N956	2N1711	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	350	58	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	97	219	°C/W

2N718A 2N956

CASE 22-03, STYLE 1 TO-18 (TO-206AA)







CASE 79-04, STYLE 1 TO-39 (TO-205AD)

> **GENERAL PURPOSE TRANSISTORS**

> > **NPN SILICON**

Refer to 2N3019 for graphs.

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS		(8/3)	0.7 = 7.0	oV 0.5 = 8:0 Vo	O mAcc, Ve	110 = 1.
Collector-Emitter Breakdown Voltage (I _C = 100 mAdc, pulsed; R _{BE} ≤ 10 ohms)(1)		VCER(sus)	50	by or - a:	u m <u>Ass</u> s, V _i	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc, I_E = 0$)	2N718A, 2N986, 2N1711	V _(BR) CBO	75	DA 0(_= 8;	S .S <u>17</u> 31 00	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \mu Adc, I_C = 0$)		V _{(BR)EBO}	7.0	_	_	Vdc
Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 60 Vdc, I _E = 0, T_A = 150°C)		ICBO	=	0.001	0.01 10	μAdc
Emitter Cutoff Current (V _{EB} = 5.0 Vdc, I _C = 0)	2N718A, 2N956, 2N1711	IEBO	=	=	0.010 0.005	μAdc
ON CHARACTERISTICS						
DC Current Gain ($I_C = 0.01 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}$)	2N956, 2N1711	hFE	20	_	_	-
$(I_C = 0.1 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$	2N718A, 2N956, 2N1711		20 35	=	_	
$(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$	2N718A, 2N956, 2N1711		35 75	=	_	
(I _C = 10 mAdc, V _{CE} = 10 Vdc, T _A = -55° C)	2N718A, 2N956, 2N1711		20 35	=	=	
$(I_C = 150 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$	2N718A, 2N956, 2N1711		40 100	=	120 300	
$(I_C = 500 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$	2N718A, 2N956, 2N1711		20 40	_	=	
Collector-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc)		V _{CE(sat)}		0.24	1.5	Vdc
Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc)		V _{BE} (sat)	_	1.0	1.3	Vdc

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Тур	Max	Unit
SMALL-SIGNAL CHARACTERISTICS		Ageria	0				
Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz)	Unit	2N718A, 2N956, 2N1711	Symple 1	60 70	300 300	R sV re tti m3	MHz
Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1 MHz)	56V	7.0	C _{obo}		4.0	25	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1 MHz)	Vilm DAWm	500 500 2.88 4.57	C _{ibo}	2000 4	20	80	pF
Input Impedance (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V _{CB} = 10 Vdc, f = 1.0 kHz)	Stratte O'Wm	1.8 3.0 10.3 17.15 -65 to + 200	hib	24 4.0	Ton @ Tc.	34 8.0	ohms
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz)		2N718A, 2N956, 2N1711	h _{rb}	= a:	Tamata.	3.0 5.0	X10-4
$(I_C = 5.0 \text{ mAdc}, V_{CB} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$		2N718A, 2N956, 2N1711		_	o <u>lis</u> hez	3.0 5.0	
Small-Signal Current Gain ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$, $f = 1.0 \text{ kHz}$) ($I_C = 5.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	AVO.	2N718A, 2N956, 2N1711 2N718A, 2N956, 2N1711	h _{fe}	30 50 35 70	A MANAGERIA	100 200 150 300	Thermal F
Output Admittance (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V _{CB} = 10 Vdc, f = 1.0 kHz)	Sym		h _{ob}	0.05 0.05	—8011 W or Whole W	0.5 0.5	μmhos
Noise Figure (I _C = 300 μ Adc, V _{CE} = 10 Vdc, f = 1.0 kHz)	V(BR)	2N718A, 2N956, 2N1711	NF (f)(a	e 10 obmi	ulsed; figg klown Volta	12 8.0	dB = dB

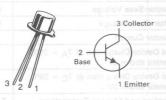
Wis Delivious Instruction					
Rating	Symbol	Value	Unit		
Collector-Emitter Voltage	VCEO	abV 80 08	Vdc		
Collector-Emitter Voltage	VCER	abV 100 0.8	Vdc		
Collector-Base Voltage	VCBO	120	⊚ Vdc		
Emitter-Base Voltage	VEBO	7.0	Vdc		
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.5 2.86	Watt mW/°C		
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.8	Watts mW/°C		
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C		

THERMAL CHARACTERISTICS

THE WALL OF A THOU THOU		4.61.55	31,00000
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta}JC$	97	°C/W

2N720A*

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Refer to 2N3019 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) Note that a seriou of a transfer of the control of the control

Hall Hall Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS			SANSTICE	TOARAGO
Collector-Emitter Breakdown Voltage(1) (I _C = 100 mAdc, R _{BE} ≤ 10 ohms)	VCER(sus)	100 / m	robite - 3 telan	Vdc
Collector-Emitter Sustaining Voltage(1) (I _C = 30 mAdc, I _B = 0)	VCEO(sus)	80	(0 = _ct,ob	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	V(BR)CBO	120	Bray to overn	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \mu Adc, I_C = 0$)	V(BR)EBO	7.0	10 - 10 100	Vdc
Collector Cutoff Current $(V_{CB} = 90 \text{ Vdc}, I_E = 0)$ $(V_{CB} = 90 \text{ Vdc}, I_E = 0, T_A = 150^{\circ}\text{C})$	СВО	-	.010 ob	μAdc
Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0)	IEBO	_	.010	μAdc
ON CHARACTERISTICS			(0 = g1,0b)	VCE = 5.0
DC Current Gain $(I_C = 0.1 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$ $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, T_A = -55^{\circ}\text{C})$ $(I_C = 150 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$		20 35 20 40	tine) 11 (0 =)b\	Hector Cuth
Collector-Emitter Saturation Voltage(1) (I _C = 50 mAdc, I _B = 5.0 mAdc) (I _C = 150 mAdc, I _B = 15 mAdc)	VCE(sat)	_	1.2 5.0	Vdc
Base-Emitter Saturation Voltage(1) $(I_C = 50 \text{ mAdc}, I_B = 5.0 \text{ mAdc})$ $(I_C = 150 \text{ mAdc}, I_B = 15 \text{ mAdc})$	V _{BE(sat)}	, T _A = 170°C	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS			Curr and	Party Cinatrie
Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz)	f _T	50	(da, (c = 0)	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1 MHz)	Cobo		15	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1 MHz)	Cibo	_	85	pF
Input Impedance (I _C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V_{CB} = 10 Vdc, f = 1.0 kHz)	hib	20 4.0	30 8.0	Ohms
Voltage Feedback Ratio ($I_C = 1.0 \text{ mAdc}$, $V_{CB} = 5.0 \text{ Vdc}$, $f = 1.0 \text{ kHz}$) ($I_C = 5.0 \text{ mAdc}$, $V_{CB} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h _{rb}	(onV a	1.25 1.50	X 10-4
Small-Signal Current Gain ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$, $f = 1.0 \text{ kHz}$) ($I_C = 5.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h _{fe}	30 45	100	Aut 01 = 01
Output Admittance (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V _{CB} = 10 Vdc, f = 1.0 kHz)	h _{ob}	5.0 Vda)	0.5 0.5	μmhos

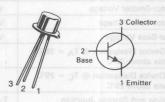
Rating	Symbol	2N930	2N930A	Unit
Collector-Emitter Voltage	VCEO	45	45	Vdc
Collector-Base Voltage	VCBO	45	60	Vdc
Emitter-Base Voltage	VEBO	5.0	6.0	Vdc
Collector Current	Ic	shV:	30	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.5 3.33		W mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.2 6.9		Watt mW/°C
Operating and Storage Temperature Temperature Range	T _J , T _{stg}	- 65 t	0 +175	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	350	°C/W	
Thermal Resistance, Junction to Case	$R_{\theta}JC$	146	°C/W	

2N930, A

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



AMPLIFIER TRANSISTORS

NPN SILICON

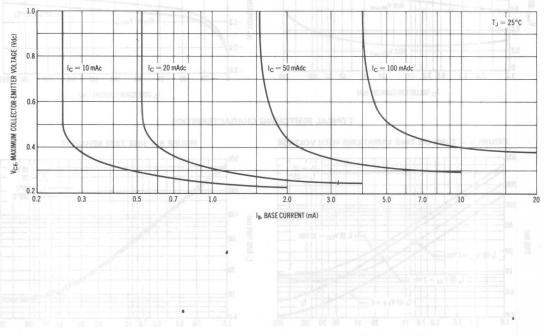
MinU KeM Characteristic		Symbol	Min	Max	Unit		
OFF CHARACTERISTICS						ENISTICS	PF CHARACT
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0)	(Eus)830	V V	Ade, Agg < 13 ohms) io le = 01	V(BR)CEO	45	iar Br kdown we Sustaining	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu Adc, I_E = 0$)	OBOTHB	2N930 2N930A		V _(BR) CBO	45 60	BrasiCown V	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)	CBO	2N930 2N930A	- 150°C)	V _{(BR)EBO}	5.0 6.0	T Imanu 7	Vdc
Collector Cutoff Current (VCE = 5.0 Vdc, IB = 0)	083			ICEO	5 - <u>7.0</u> Vdg	2.0	nAdc
Collector Cutoff Current (V _{CB} = 45 Vdc, I _E = 0)	93/1	2N930 2N930A	(3*88-) =	ICBO -	mAdo, Vos mAdo Vos mAdo, Vos	10 2.0	nAdc
Collector Cutoff Current (V _{CB} = 45 Vdc, V _{BE} = 0)	(CE(sat)	2N930 2N930A	ic, ig = 5.0 mAdc) dc, ig = 15 mAdc)		MAda, V _{OL}	10 2.0	nAdc
(V _{CE} = 45 Vdc, V _{BE} = 0, T _A = 170°C	(tee)39\	2N930 2N930A				10 2.0	μAdc
Emitter Cutoff Current (VEB = 5.0 Vdc, I _C = 0)	fg Coton	2N930 2N930A	/cs - 10 Vdc; f - 26 J	IEBO	Product (lg	10 2.0	nAdc
ON CHARACTERISTICS	Cress		(5	HIM I - I Do	0.5.Vde. Jo.	e mil ann	out Campoits
DC Current Gain (I _C = 1.0 μ Adc, V _{CE} = 5.0 Vdc)	dirl	2N930A	(s)(d) (0,) = (s)(d) (0,)	hee hee	60	300	put impedal
$(I_C = 1.0 \ \mu Adc, V_{CE} = 5.0 \ Vdc)$					MARTOIT = :		ollage Feadb
(I _C = 10 μ Adc, V _{CE} = 5.0 Vdc, T _A =	-55°C)	2N930 2N930A				nieū m onuč	mall-Signal
$(I_C = 500 \ \mu Adc, V_{CE} = 5.0 \ Vdc)$		2N930 2N930A		:g = 5.0 Vdc. :g = 10 Vdc.		= 3l)_eans	tlmbA tuqtu
$(I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})(1)$		2N930 2N930A		y Cycla ≤ 2.09	300 ps, Out	600 600	Pulse Tast: I

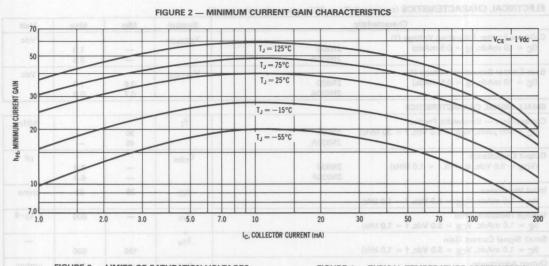
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

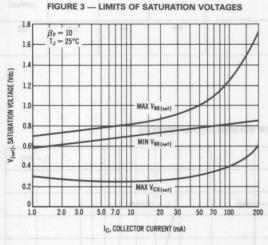
Characteristic			Symbol	Min	Max	Unit
Collector-Emitter Saturation Voltage (1) (I _C = 10 mAdc, I _B = 0.5 mAdc)	2N930 2N930A	0.511 – 17	V _{CE(sat)}		1.0 0.5	Vdc
Base-Emitter Saturation Voltage (1) (I _C = 10 mAdc, I _B = 0.5 mAdc)	2N930 2N930A	3.62 - 1	V _{BE(sat)}	0.6 0.7	1.0 0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS	and the second second second second	71150				-
Current-Gain — Bandwidth Product (IC = 500 μ Adc, VCE = 5.0 Vdc, f = 30 MHz)	2N930 2N930A	Da86 T.	fT	30 45	_	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	2N930 2N930A		C _{obo}	=	8.0 6.0	pF
Input Impedance (I _E = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz)			h _{ib}	25	32	ohms
Voltage Feedback Ratio (I _E = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz)	05	61 0.7	h _{rb}	3.0	600	X 10-6
Small Signal Current Gain $(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc}, f = 1.0 \text{ kHz})$	(NEW) 16FANISTO 1804/3/27000 594		h _{fe}	150	600	
Output Admittance (IE = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	RGURE 4	LYAGES	h _{ob}	IB 40 ETIMIJ	_ 8 1.0 (2014	μ mhos
Noise Figure (I _C = 10 µAdc, V _{CE} = 5.0 Vdc R _S = 10 k ohms, f = 1.0 kHz)	0.1+	VIII	NF		3.0	dB

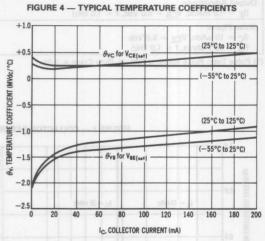
(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.



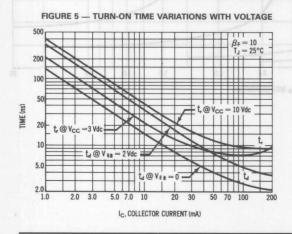


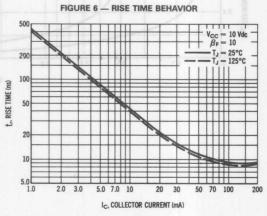


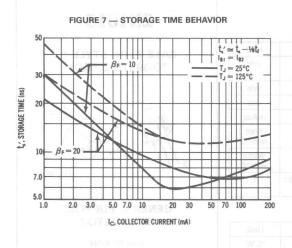




TYPICAL SWITCHING CHARACTERISTICS









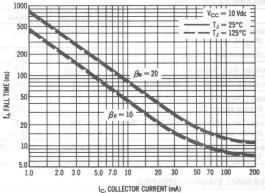


FIGURE 9 — JUNCTION CAPACITANCE VARIATIONS

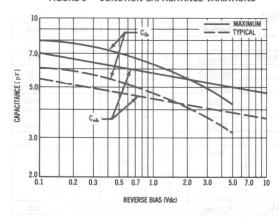
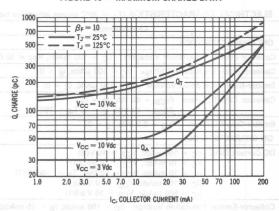


FIGURE 10 — MAXIMUM CHARGE DATA



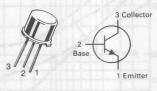
Rating	Symbol	Value	Unit
Collector-Emitter Voltage (R _{BE} ≤ 10 Ohms)	VCER	50	Vdc
Collector-Base Voltage	VCBO	75	Vdc
Emitter-Base Voltage	VEBO	7.0	Vdc
Collector Current — Continuous	Ic	500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.8 4.57	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	3.0 17.15	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	219	°C/W
Thermal Resistance, Junction to Case	R_{θ} JC	58	°C/W

2N1613

CASE 79-04, STYLE 1 TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS			TIN		
Collector-Emitter Breakdown Voltage(1) (I _C = 100 mAdc, R _{BE} ≤ 10 Ohms)	VCER(sus)	50			Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	V(BR)CBO	75			Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)	V(BR)EBO	7.0			Vdc
Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 60 Vdc, I _E = 0, T _A = 150°C)	ІСВО	4		10 10	nAdc μAdc
Emitter Cutoff Current (V _{EB} = 5.0 Vdc, I _C = 0)	IEBO			10	nAdc
ON CHARACTERISTICS					9.0
DC Current Gain (I _C = 100 μ Adc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc)(1) (I _C = 10 mAdc, V _{CE} = 10 Vdc, T _A = -55°C)(1) (I _C = 150 mAdc, V _{CE} = 10 Vdc)(1) (I _C = 500 mAdc, V _{CE} = 10 Vdc)(1)	hFE	20 35 20 40 20	35 50 — 80 30	120	0.6
Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc)(1)	V _{CE(sat)}	_	0.3	1.5	Vdc
Base-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc)(1)	V _{BE(sat)}		0.78	1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (IC = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz)	fT	60	_	<u> </u>	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}		10	25	pF
Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 1.0 MHz)	Cibo		50	80	pF
Input Impedance (I _C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz (I _C = 5.0 mAdc, V_{CB} = 10 Vdc, f = 1.0 kHz)	hib	24 4.0	=	34 8.0	Ohms
Voltage Feedback Ratio ($I_C = 1.0 \text{ mAdc}$, $V_{CB} = 5.0 \text{ Vdc}$, $f = 1.0 \text{ kHz}$) ($I_C = 5.0 \text{ mAdc}$, $V_{CB} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h _{rb}	Ξ	=	3.0 3.0	X 10-4
Small-Signal Current Gain (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h _{fe}	30 35	=	100 150	-
Output Admittance ($I_C = 1.0 \text{ mAdc}$, $V_{CB} = 5.0 \text{ Vdc}$, $f = 1.0 \text{ kHz}$) ($I_C = 5.0 \text{ mAdc}$, $V_{CB} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h _{ob}	0.05 0.05		0.5 0.5	μmhos
Noise Figure ($I_C = 0.3$ mAdc, $V_{CE} = 10$ Vdc, $R_S = 510$ Ohms, $f = 1.0$ kHz, Bandwidth = 1.0 Hz)	NF		_	12	dB
SWITCHING CHARACTERISTICS					
Switching Time	$t_d + t_r + t_f$	_	_	30	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

2N1711 For Specifications, See 2N718A Data.

MAXIMUM RATINGS

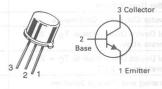
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	90 Vde	○ Vdc
Collector-Emitter Voltage	VCER	s6V 100	□ Vdc
Collector-Base Voltage	VCBO	35V 120	Vdc
Emitter-Base Voltage	VEBO	ob√ 7.0	Vdc
Collector Current — Continuous	IC	DA 0.5	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.8 4.57	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	3.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	219	°C/W
Thermal Resistance, Junction to Case	R_{θ} JC	WAS 58	°C/W

2N1893

CASE 79-04, STYLE 1 TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTOR NPN SILICON

Refer to 2N3019 for graphs.

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	App. (30) = 54)	nettal/ take	altris et al matiti	n 3 anthello
Collector-Emitter Breakdown Voltage (IC = 100 mAdc, RBE = 10 ohms)(1)	VCER(sus)	100	elacu Tuvisie	Vdc
Collector-Emitter Sustaining Voltage(1) (I _C = 30 mAdc, I _B = 0)(1)	V _{CEO(sus)}	80	heles Tastte	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc, I_E = 0$)	V(BR)CBO	120	woll si z ik ne	Vdc
Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0)	V(BR)EBO	7.0	Investment of	Vdc
Collector Cutoff Current (V _{CB} = 90 Vdc, I _E = 0) (V _{CB} = 90 Vdc, I _E = 0, T _A = 150°C)	ІСВО	08 = ggV)	0.01 15	μAdc
Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0)	IEBO	V 0 2 a pa	0.01	μAdc
ON CHARACTERISTICS			POWT SERVICES	LAGRASE'S ME
DC Current Gain $(I_C = 0.1 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$ $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, T_A = -55^{\circ}\text{C})(1)$ (IC = 150 mAdc, V _{CE} = 10 Vdc)(1)	E = 10 Vdel(2) E = 10 Vdel(2) E = 10 Vdel(2)	20 35 20 40	120	C Current
Collector-Emitter Saturation Voltage(1) (I _C = 50 mAdc, I _B = 5.0 mAdc) (I _C = 150 mAdc, I _B = 15 mAdc)	VCE(sat)	500 (M ide.	1.2 0.5	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 50 \text{ mAdc}$, $I_B = 5.0 \text{ mAdc}$) ($I_C = 150 \text{ mAdc}$, $I_B = 15 \text{ mAdc}$)	V _{BE} (sat)	on V et ians	0.9 1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS		and place	Maraka Lash	DOZ. FLANC
Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz)	fT	50	inestruction is seen	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	Cobo	_	15	pF
nput Capacitance (VEB = 0.5 Vdc, IC = 0, f = 1.0 MHz)	Cibo	obV 01 = g	85	pF
Input Impedance (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V _{CB} = 10 Vdc, f = 1.0 kHz)	or hib	20 4.0	30 8.0	Ohms

Current-Gain — Bandwidth Froduct (IC = 50 mAde, VCE = 10 vdc, 1 = 20 min2)	married - of	30	Invitarialis see r	IVITIZ
Output Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_{E} = 0$, $f = 1.0 \text{ MHz}$)	Cobo	_	15	pF
Input Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	Cibo	yl ob V ot + g	85	pF pF
Input Impedance (I _C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V_{CB} = 10 Vdc, f = 1.0 kHz)	h _{ib}	20 4.0	30 8.0	Ohms
Voltage Feedback Ratio (I _C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V_{CB} = 10 Vdc, f = 1.0 kHz)	h _{rb}	5/ ,0b=0.0 No = 1 0 mA	1.25 1.5	X 10-4
Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz)	h _{fe}	30 45	100	ani?.iiam2
Output Admittance ($I_C = 1.0 \text{ mAdc}$, $V_{CB} = 5.0 \text{ Vdc}$, $f = 1.0 \text{ kHz}$) ($I_C = 5.0 \text{ mAdc}$, $V_{CB} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h _{ob}	r t a - - j l)	0.5 0.5	μmho

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	65	□ Vdc
Collector-Emitter Voltage, RBE ≤ 10 Ohms	VCER	80	Vdc
Collector-Base Voltage	VCBO	120	Vdc
Emitter-Base Voltage	VEBO	7.0	Vdc
Collector Current — Continuous	IC	sbA 1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 5.71	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit	l
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	175	°C/W	
Thermal Resistance, Junction to Case	$R_{\theta,IC}$	35	°C/W	

2N2102

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	SUSTAIN	Charte			
Collector-Emitter Breakdown Voltage (I _C = 100 mAdc, R _{BE} ≤ 10 ohms)(2)	VCER(sus)	80	80	ACTURES	Vdc
Collector-Emitter Sustaining Voltage(2) (I _C = 100 mAdc, I _B = 0)(2)	V _{CEO(sus)}	65	ikdo <u>we</u> Vp	estil sessim	Vdc
Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, V _{EB} = 1.5 Vdc)	V(BR)CEX	120	lov gninis	mitter Stu	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0)	V(BR)CBO	120	String V Prints	DEDE BES	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \mu Adc, I_C = 0$)	V(BR)EBO	7.0	Was Volume	SUPPRESSON	Vdc
Collector Cutoff Current (VCB = 60 Vdc, I_E = 0) (VCB = 60 Vdc, I_E = 0, T_A = 150°C)	ІСВО	90 Vda, I 90 <u>V</u> da, I	85 <u>V</u>) In	2.0 2.0	nAdc μAdc
Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0)	IEBO	a Age IC	= 83V) 1	2.0	nAdc
ON CHARACTERISTICS				ersonerrog	HARD M
DC Current Gain $(I_C = 0.1 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(2)$ $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, T_A = -55^{\circ}\text{C})(2)$ $(I_C = 150 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(2)$ $(I_C = 500 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(2)$ $(I_C = 1.0 \text{ Adc}, V_{CE} = 10 \text{ Vdc})(2)$	hFE A AN A	20 35 20 40 25	IAM 1.0 = 0Am 0? = 0A		B-notalle
Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc)(2)	VCE(sat)	= = (1	0.15	0.5	Vdc
Base-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc)(2)	V _{BE} (sat)	= 20	0.88	1.1	Vdc
SMALL-SIGNAL CHARACTERISTICS		GOV	EMETOAN	AND THRE	16-11/10/2
Current-Gain — Bandwidth Product $(I_C = 50 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 20 \text{ MHz})$	50 ft (s)	60	VGB = 18	nn — Band Daoitanac	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	Cobo	u e - l at	6.0	15	pF
Input Capacitance ($V_{EB} = 0.5 \text{ Vdc}$, $I_{C} = 0$, $f = 1.0 \text{ MHz}$)	Cibo	= 8 3 / 51	50	80	pF
Input Impedance (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	hib	24 4.0	Arts <u>0.3</u> =	34 8.0	Ohms
Voltage Feedback Ratio (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h _{rb}	,ab <u>A</u> m. 0. µAr . 0 . 1. ⇒	= <u>all</u> gl) →ris0	3.0	X 10-4
Small-Signal Current Gain (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h _{fe}	30 35	19.1-01	100 150	έιδΑ πυφέυε
Output Admittance ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$, $f = 1.0 \text{ kHz}$) ($I_C = 5.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h _{ob}	0.01 0.01	(Ic = 500 n (Idm = 300	0.5 1.0	μmho
Noise Figure $(I_C=300~\mu Adc, V_{CE}=10~Vdc, R_S=1.0~k~Ohm, f=1.0~kHz, Bandwidth=1.0~Hz)$	NF	-	4.0	6.0	dB
SWITCHING CHARACTERISTICS				THE PARTY	
Switching Time	$t_d + t_r + t_f$		_	30	ns

gleD Rating	Symbol	2N2219 2N2222	2N2218A 2N2219A 2N2222A	Unit
Collector-Emitter Voltage	VCEO	30	40	Vdc
Collector-Base Voltage	VCBO	60	75	Vdc
Emitter-Base Voltage	V _{EBO}	5.0	6.0	Vdc
Collector Current — Continuous	Ic	800	800	mAdc
- US 34		2N2218A 2N2219,A	2N2222,A	A813
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.8 4.57	0.4 2.28	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	3.0 17.1	1.2 6.85	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to	o +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	2N2218A 2N2219,A	2N2222,A	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	219	437.5	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	58	145.8	°C/W

2N2218A,2N2219,A* 2N2222,A*

2N2218, A/2N2219,A CASE 79-04 TO-39 (TO-205AD) STYLE 1





A/2N2222,A CASE 22-03 TO-18 (TO-206AA) STYLE 1

GENERAL PURPOSE TRANSISTORS

NPN SILICON

★2N2219A and 2N2222A are Motorola designated preferred devices.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Char	acteristic		XII	tad. Aerii	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				KITTUS	in.O.		-	
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	5(0	Non-A Suffix A-Suffix	ZN2222A	2218A 2219A	V(BR)CEO	30 40	л э <u>У</u> св = —	Vdc
Collector-Base Breakdown Voltage (I _C = 10 μ Adc, I _E = 0)		Non-A Suffix A-Suffix	2N2222A	2218A, 2218A,	V(BR)CBO	60 75	= ap7 - 10	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)		Non-A Suffix A-Suffix	2/42222A	2218A	V(BR)EBO	5.0 6.0	apV /rt	Vdc
Collector Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc)		A-Suffix	2N2222A	2218A 0218A	ICEX	10 V <u>da</u> f =	3 10	nAdc
Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0) (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 50 Vdc, I _E = 0, T _A = 150°C) (V _{CB} = 60 Vdc, I _E = 0, T _A = 150°C)	^O lu	Non-A Suffix A-Suffix Non-A Suffix A-Suffix	ZNZZZZA	2218A 2218A	ICBO	10 10 10 10 10 10 10 10 10 10 10 10 10 1	0.01 0.01 10	μAdc
Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0)	Holl	A-Suffix	Annautic	(Acid) ESI	IEBO	_	10	nAdc
Base Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc)	0	A-Suffix	2N 22 22A	2218A,	I _{BL}	1.307.01	20	nAdc
ON CHARACTERISTICS				ARTSN	1.0 kHz 2h	H 1 ShV of	= 35V . 84	m 01 = 3ll
DC Current Gain $(I_C = 0.1 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$	o Di chi	2N2218A 2N2219,A, 2N2222	2,A	AEPSXI Suffix	h _{FE}	20	no3 . : = 80 + -3	Collector E (IE = 20 m
$(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$		2N2218A 2N2219,A, 2N2222	2,A		20	25 50	EO T	Noise Figure (IC = 100 . RS = 1.0
$(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$		2N2218A 2N2219,A, 2N2222			306 MHz) 21	35 75	mt h <u>un</u> o VOE =	Real Part of Righ Frequen IIC = 20
$(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc},$ $T_A = -55^{\circ}\text{C})(1)$		2N2218A 2N2219,A, 2N2222	2,A		ge July Cysls ≈ 2.	15 35	Hibila—	Puise Test
$(I_C = 150 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$		2N2218A 2N2219,A, 2N2222			ion his exitap and Cab for the	40 100	120 300	9 iy is define ii 2N5581 and

 $\textbf{ELECTRICAL CHARACTERISTICS} \ (continued) \ (T_{\mbox{\scriptsize A}} = 25^{\circ}\mbox{C unless otherwise noted.})$

Characteristic	AMILE ALTERNATION	3433773	Symbol	Min	Max	Unit
//- 450 Ad- W- 4.0 V/d-V/1	20122124	0.6		20	agatrioV ret	Im3-rotoel
$(I_C = 150 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})(1)$	2N2218A	0.03		20 50	Volume	leptor-Suse
	2N2219,A, 2N2222,A	8.0		50	epofici	Liter-Bass
$(I_C = 500 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$	2N2219, 2N2222	dolla		30		
(IC = 200 HIAGE, ACE = 10 AGE)(1)	2N2218A	908		25	UnoQ - Ins	ALPO TORBEI
	2N2219A, 2N2222A	ABISSMS		40		
Callantas Fraittas Catamatias Valta ad (1)	271221071/ 2112222	A Procus	V			Vdc
Collector-Emitter Saturation Voltage(1)	Non-A Suffix		VCE(sat)		0.4	Solved
(I _C = 150 mAdc, I _B = 15 mAdc)	A-Suffix	8.0			0.4	B - AT
	A-Sullix	4.67			0.300	vods etsne
(I _C = 500 mAdc, I _B = 50 mAdc)	Non-A Suffix			_	1.6	al Davice In
A.S.S.S.S.M.S.L.A.	A-Suffix	3.0		_	1.0	PTC = 28
Base-Emitter Saturation Voltage(1)	J.W/m ca.d	17/1	V _{BE(sat)}		0.42.6	Vdc
(I _C = 150 mAdc, I _B = 15 mAdc)	Non-A Suffix	or 28 -	*BE(Sat)	0.6	1.3	one ondere
(IC = 100 IIIAdo, IB = 10 IIIAdo)	A-Suffix			0.6	1.2	
	/ Cullix				RETOARAN	
(I _C = 500 mAdc, I _B = 50 mAdc)	Non-A Suffix			BOITE	2.6	D.JAMRS
ALCOHOLD TO SERVICE STATE OF THE PARTY OF TH	A-Suffix	ASTERME		_	2.0	
SMALL-SIGNAL CHARACTERISTICS	1110 A,5500-3	Walders	mentide		Security and	
20/23/22/20/	1000 C.000	1 013	AUL III	Mark words	ומו וכני, לטווט	DAL!-
Current Gain — Bandwidth Product(2)	All Types Eveent	88	fT	250	tanca, June	MHz
$(I_C = 20 \text{ mAdc}, V_{CE} = 20 \text{ Vdc}, f = 100 \text{ MHz})$	All Types, Except 2N2219A, 2N2222A			300		
- Access of voted	ZINZZIBA, ZINZZZZA			300		
Output Capacitance(3) (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)			C _{obo}		8.0	pF
nput Capacitance(3)		stwm/the say	Cibo	enancs (TOARAHO.	pF
(VEB = 0.5 Vdc, IC = 0, f = 1.0 MHz)	Non-A Suffix	417	alialustoss	43 -	30	111111111111111111111111111111111111111
	A-Suffix			_	25	MARKET I
Input Impedance			hje			kohms
$(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$	2N2218A			1.0	3.5	Internation
92	2N2219A, 2N2222A	m-A Suffix		2.0	8.0	AD 01 = 3
		xiMut				
$(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$	2N2218A			0.2	1.0	lactor-Bass
- 70	2N2219A, 2N2222A	ming A-m	M. The second	0.25	1.25	AU 01 - 5
Voltage Feedback Ratio		ximue	h _{re}			X 10-
$(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$	2N2218A			- egano	5.0	Rice Bose
	2N2219A, 2N2222A	XIIIu8 A-re		-	8.0	E = 10 M
(lo = 10 mAde Ve= = 10 Vde f = 10 kH=)	2N2218A	XHOM			2.5	
$(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$	2N2219A, 2N2222A				4.0	lector Culx
	ZINZZIJA, ZINZZZZA	20002	-0	Laby D.E.	4.0	18 - 201
Small-Signal Current Gain	01100404		h _{fe}		the Current	lector Ceta
$(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$	2N2218A	willing A-m		30	150	18 = 80V
	2N2219A, 2N2222A	Miller		50	300	(cg = 60)
(I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	2N2218A	with Suttin		50	300	1CB = 20
(IC = 10 HIAGE, VCE = 10 VGE, 1 = 1.0 KHZ)	2N2219A, 2N2222A	ximic		75	375	18 = 83/
about of cast	LITELION, LITELLEN			,,,	THE THE	TOUGH COOK
Output Admittance	2N2218A	million .	hoe	3.0	15	μmho
$(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$	2N2219A, 2N2222A			5.0	35	O Menu D ea
	ZINZZ IBA, ZINZZZZA	sittu2		3.0 Vdc	35	18 - anti
$(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$	2N2218A			10	100	CHARACT
THE	2N2219A, 2N2222A			15	200	The state of the s
Collector Base Time Constant		Alltes	rh'C		150	ne
($I_E = 20 \text{ mAdc}$, $V_{CB} = 20 \text{Vdc}$, $f = 31.8 \text{ MHz}$)	A-Suffix	DAS ABISS	rb'C _C	(ctrl/ OT	150	ps
Noise Figure			NF		4.0	- AD
Voise Figure $(I_C = 100 \mu Adc, V_{CE} = 10 Vdc,$		12218A	1S	(sbV of	4.0	dB
$R_S = 1.0 \text{ kohm}, f = 1.0 \text{ kHz})$	2N2222A	SHE ALTER				
			D-/I- \		- 00	01
Real Part of Common-Emitter		2218A	Re(hje)	(7)(00 V 01	60	Ohms
High Frequency Input Impedance (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 300 MHz)	2N2218A, 2N2219A	12219 AL 2NZ		1 1 1 1		
11C 20 111Ado, VCE - 20 Vdc, 1 - 300 WITZ)	2N2210A, ZNZZ13A					

⁽¹⁾ Pulse Test: Pulse Width $\leq 300~\mu s$, Duty Cycle $\leq 2.0\%$. (2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity. (3) 2N5581 and 2N5582 are Listed C_{Cb} and C_{eb} for these conditions and values.

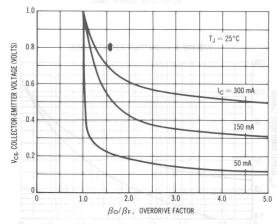
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
SWITCHING CHARA	CTERISTICS				
Delay Time	$(V_{CC} = 30 \text{ Vdc}, V_{BE(off)} = -0.5 \text{ Vdc},$	t _d		10	ns
Rise Time	I _C = 150 mAdc, I _{B1} = 15 mAdc) (Figure 12)	t _r	-	25	ns
Storage Time	(V _{CC} = 30 Vdc, I _C = 150 mAdc,	t _S	100	225	ns
Fall Time	I _{B1} = I _{B2} = 15 mAdc) (Figure 13)	tf		60	ns
Active Region Time (I _C = 150 mAdc, \ 2N2221A, 2N2222	/CE = 30 Vdc) (See Figure 11 for 2N2218A, 2N2219A,	TA		2.5	ns

FIGURE 1 - NORMALIZED DC CURRENT GAIN



FIGURE 2 - COLLECTOR CHARACTERISTICS IN SATURATION REGION



This graph shows the effect of base current on collector current. β_o (current gain at the edge of saturation) is the current gain of the transistor at 1 volt, and β_r (forced gain) is the ratio of $I_c/I_{I\!\!P}$ in a circuit.

EXAMPLE: For type 2N2219, estimate a base current (I_{μ}) to insure saturation at a temperature of 25 °C and a collector current of 150 mA.

Observe that at I $_c=150$ mA an overdrive factor of at least 2.5 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that h $_{\rm ft}$ @ 1 volt is approximately 0.62 of h $_{\rm ft}$ @ 10 volts. Using the guaranteed minimum gain of 100 @ 150 mA and 10 V, $\beta_{\rm o}=62$ and substituting values in the overdrive equation, we find:

$$\frac{\beta_{o}}{\beta_{E}} = \frac{h_{FE} \otimes 1.0 \text{ V}}{I_{c}/I_{BF}}$$
 $2.5 = \frac{62}{150/I_{BF}}$ $I_{BF} \approx 6.0 \text{ mA}$



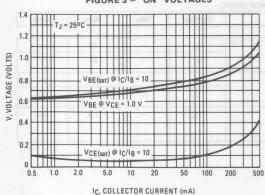
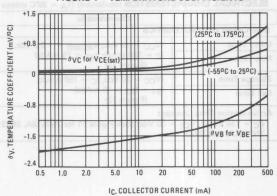


FIGURE 4 - TEMPERATURE COEFFICIENTS



h PARAMETERS

 $V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz}, T_A = 25^{\circ}\text{C}$

This group of graphs illustrates the relationship between h_{fe} and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were selected and the same units were used to develop the correspondingly numbered curves on each graph.

FIGURE 5 — INPUT IMPEDANCE

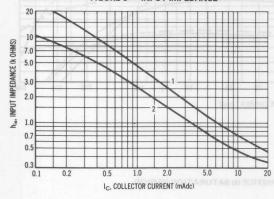


FIGURE 6 — VOLTAGE FEEDBACK RATIO

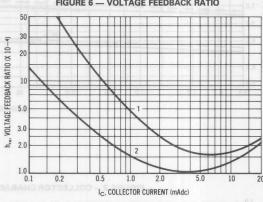


FIGURE 7 — CURRENT GAIN

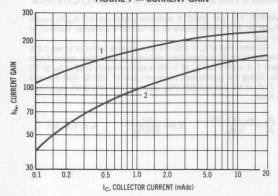
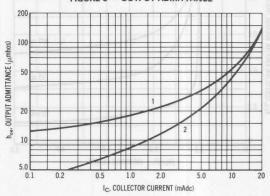
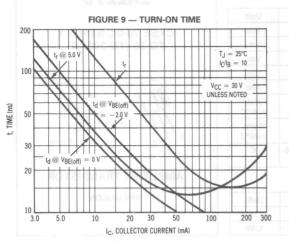


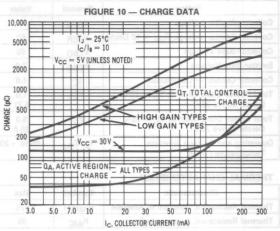
FIGURE 8 — OUTPUT ADMITTANCE

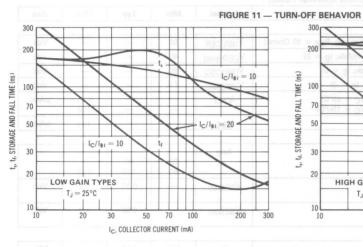


2N2218A 2N2219.A 2N2222.A

SWITCHING TIME CHARACTERISTICS







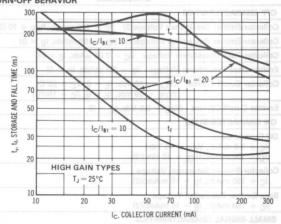


FIGURE 12 — DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

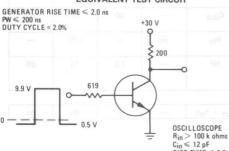
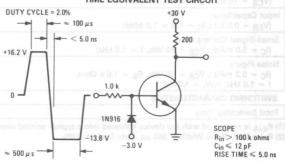


FIGURE 13 — STORAGE TIME AND FALL TIME EQUIVALENT TEST CIRCUIT



RISE TIME ≤ 5.0 ns

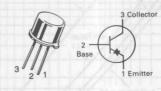
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	45	Vdc
Collector-Emitter Voltage, RBE ≤ 10 Ohms	VCER	60	Vdc
Collector-Base Voltage	VCBO	60	Vdc
Emitter-Base Voltage	VEBO	7.0	Vdc
Collector Current — Continuous	Ic	1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 5.71	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

THEMMAL CHANACTERISTICS			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	175	°C/W
Thermal Resistance, Junction to Case	Raic	35	°C/W

2N2270

CASE 79-04, STYLE 1 TO-39 (TO-205AD)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic MANAGER AND	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					والحرا
Collector-Emitter Breakdown Voltage(2) (I _C = 100 mAdc, R _{BE} ≤ 10 Ohms)	V(BR)CER	60	-	1 - 1	Vdc
Collector-Emitter Sustaining Voltage(2) (I _C = 100 mAdc, I _B = 0)	V _{CEO(sus)}	45	-		Vdc
Collector-Base Breakdown Voltage (I _C = 0.05 μAdc, I _E = 0)	V(BR)CBO	60		1/-	Vdc
Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0)	V(BR)EBO	7.0	1		Vdc
Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0, T _C = 25°C) (V _{CB} = 60 Vdc, I _E = 0, T _C = 150°C)	ІСВО		1	0.05 100	μAdc
Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0)	IEBO		/	100	nAdc
ON CHARACTERISTICS		M	1		
DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 150 mAdc, V _{CE} = 10 Vdc)(2)	hFE	30 50	90 135	200	
Collector-Emitter Saturation Voltage (IC = 150 mAdc, I _B = 15 mAdc)(2)	VCE(sat)		0.15	0.9	Vdc
Base-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc)(2)	V _{BE} (sat)	G1 01	0.88	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS		THE THE PARTY	Sensing 2	311-11-	
Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 100 MHz)	fT	100	250	_	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	AND <u>E</u> ISE TECHCULT	10	15	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	C _{ibo}		60	80	pF
Small-Signal Current Gain (IC = 5.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz)	h _{fe}	50	-	275	-
Noise Figure $(I_C = 0.3 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, R_S = 1.0 \text{ k Ohm}, f = 1.0 \text{ kHz}, B.W. = 1.0 \text{ Hz})$	NF	-	7.0	10	dB
SWITCHING CHARACTERISTICS			1	MA-0	
Total Switching Time	ton + toff	- X		30	ns

SWITCHING TIME CHARACTERISTICS

⁽¹⁾ R_{ØJA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width \leqslant 300 μ s, Duty Cycle \leqslant 2.0%.

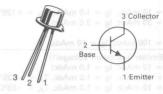
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	15	Vdc
Collector-Emitter Voltage	VCES	40	Vdc
Collector-Base Voltage	V _{CBO}	40	Vdc
Emitter-Base Voltage	V _{EBO}	4.5	Vdc
Collector Current (10 µs pulse)	IC(Peak)	500	mA
Collector Current — Continuous	IC	200	mA
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.36 2.06	Watt mW/°C
Total Device Dissipation @ T _C = 100°C	PD	.68	Watts
Derate above 100°C	V8E(set)	6.85	mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	486	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	147	°C/W

2N2369,A*

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



SWITCHING TRANSISTORS

NPN SILICON

★2N2369A is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
OFF CHARACTERISTICS						emiT austro
Collector-Emitter Breakdown Voltage (I _C = 10 μA, V _{BE} = 0)			V(BR)CES	40	il m Ad e, Ig	Vdc
Collector-Emitter Sustaining Voltage(1) (IC = 10 mAdc, IB = 0)		(abV 0.0 =	V _{CEO(sus)}	= <u>c</u> 15Am (ic. f ar = 3,	Vdc all
Collector-Base Breakdown Voltage (I _C = 10 μA, I _B = 0)		(ohV 0.E =	V _(BR) CBO	40	to let establish	Vdc 31
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc$, $I_C = 0$)			V(BR)EBO	4.5	_	Vdc
Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) (V _{CB} = 20 Vdc, I _E = 0, T _A = 150°C)	2N2369 2N2369A		ICBO	=	0.4 30	μAdc
Collector Cutoff Current (V _{CE} = 20 Vdc, V _{BE} = 0)	2N2369A		ICES	_	0.4	μAdc
Base Current (V _{CE} = 20 Vdc, V _{BE} = 0)	2N2369A		ΙB	-	0.4	μAdc
ON CHARACTERISTICS	14					
DC Current Gain(1) $(I_C = 10 \text{ mAdc, V}_{CE} = 1.0 \text{ Vdc})$	2N2369 2N2369A		hFE	40 —	120 120	_
(I _C = 10 mAdc, V_{CE} = 1.0 Vdc, T_{A} = -55° C)	2N2369			20	_	
$(I_C = 10 \text{ mAdc}, V_{CE} = 0.35 \text{ Vdc}, T_A = -55^{\circ}\text{C})$ $(I_C = 30 \text{ mAdc}, V_{CE} = 0.4 \text{ Vdc})$	2N2369A 2N2369A			20 30	_	

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)	FI FCTRICAL	CHARACTERISTICS	(continued) (Ta	= 25°C unless	otherwise noted)
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Characteristic			Symbol	Min	Max	Unit
(I _C = 100 mAdc, V _{CE} = 1.0 Vdc)	2N2369A	92	VCBO	20	agatloV	llector-Bass
(I _C = 100 mAdc, V _{CE} = 2.0 Vdc)	2N2369		oasV	20	_costlo	itter-Base V
Collector-Emitter Saturation Voltage(1) (I _C = 10 mAdc, I _B = 1.0 mAdc)	2N2369	500	(VCE(sat)		0.25	Vdc
	2N2369A		ol le	= sugi	0.20	Hector Curre
(I _C = 10 mAdc, I _B = 1.0 mAdc, T _A = $+125$ °C) (I _C = 30 mAdc, I _B = 3.0 mAdc)	2N2369A 2N2369A		α ^q	Ξ	0.30 0.25	tal Device D g TA = 25° Derate above
(I _C = 100 mAdc, I _B = 10 mAdc)	2N2369A		69	_	0.50	tal Device D
Base-Emitter Saturation Voltage(1) (I _C = 10 mAdc, I _B = 1.0 mAdc)	All Types	88. 88.6	V _{BE} (sat)	0.70	0.85	Vdc
$(I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc}, T_A = +125^{\circ}\text{C})$ $(I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc}, T_A = -55^{\circ}\text{C})$	2N2369A 2N2369A		TJ, Tag	0.59	1.02	erating and femberature
(I _C = 30 mAdc, I _B = 3.0 mAdc)	2N2369A			-	1.15	
(I _C = 100 mAdc, I _B = 10 mAdc)	2N2369A			sno <u>s</u>	1.60	ERMAL C
SMALL-SIGNAL CHARACTERISTICS	Statz	xeld	Symbol		harnotoristic	
Current-Gain — Bandwidth Product	W/O	989	Afr	500	iponui_cons	MHz
$(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 100 \text{ MHz})$	- CVA	563	Page	ses0 or no	ance, Janet	sizaR Isme
Output Capacitance $(V_{CB} = 5.0 \text{ Vdc}, I_{E} = 0, f = 1.0 \text{ MHz})$			C _{obo}		4.0	pF
Input Capacitance (VEB = 1.0 Vdc, I _C = 0, f = 1.0 MHz)		.batun esiwaadzo	Cibo	RISTICS (T	4.0	pF

SWITCHING CHARACTERISTICS

Storage Time (I _C = I _{B1} = 10 mAdc, I _{B2} = -10 mAdc)	t _S	m Voltage	13	ns
Turn-On Time (I _C = 10 mAdc, I _{B1} = 3.0 mA, I _{B2} = -1.5 mA, V _{CC} = 3.0 Vdc)	ton	Voltage(1)	12 dV	ns Im3-rotos
Turn-Off Time (I _C = 10 mAdc, I _{B1} = 3.0 mA, I _{B2} = -1.5 mA, V _{CC} = 3.0 Vdc)	toff	egastoV	18	ns

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUITS FOR 2N2369, 2N3227

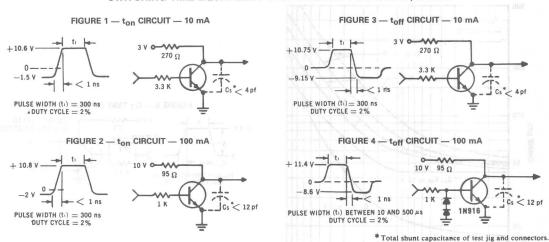
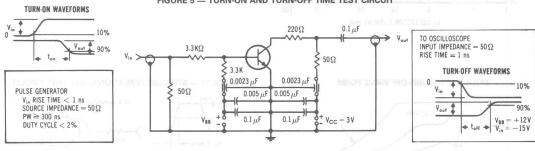


FIGURE 5 — TURN-ON AND TURN-OFF TIME TEST CIRCUIT



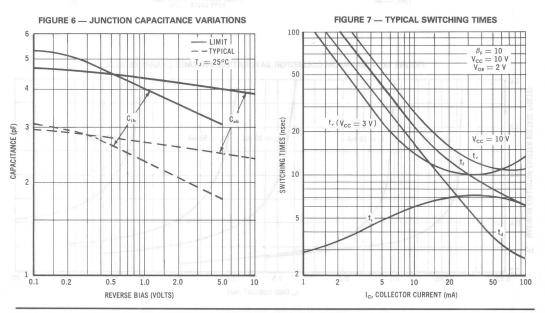
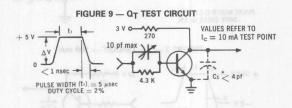
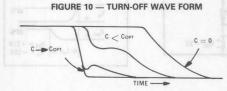
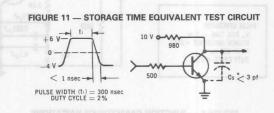
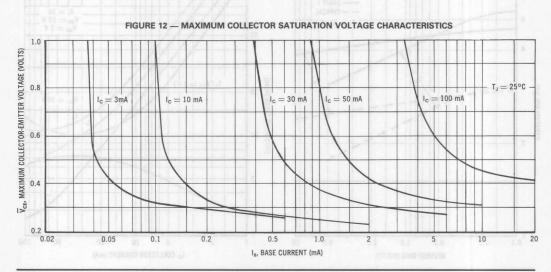


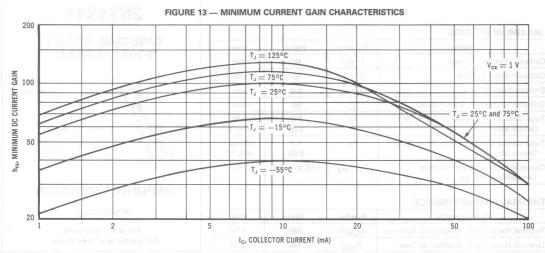
FIGURE 8 — MAXIMUM CHARGE DATA 500 $V_{cc} = 10 \text{ V}$ — — −100°C 25°C Q_T , $\beta_F = 10$ 200 Q_T , $\beta_F = 40$ 100 CHARGE (pC) 50 QA, Vcc = 10 V Q_A , $V_{CC} = 3 V$ 20 10 50 100 10 Ic, COLLECTOR CURRENT (mA)

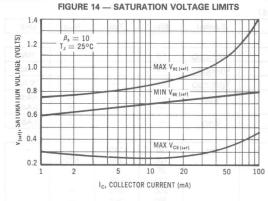


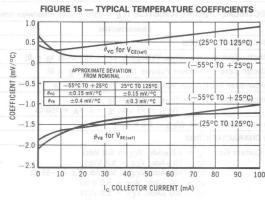












Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	60	Vdc
Collector-Base Voltage	VCBO	60	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	Ic	50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	360 2.06	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.2 6.85	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	485	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	146	°C/W

2N2484*

CASE 22-03, STYLE 1 TO-18 (TO-206AA)





AMPLIFIER TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	NULL			01 = 4	2, 3
Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0)	V(BR)CEO	60		-	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu Adc, I_E = 0$)	V(BR)CBO	60	-	-	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V(BR)EBO	6.0	11-	-	Vdc
Collector Cutoff Current (V _{CB} = 45 Vdc, I _E = 0) (V _{CB} = 45 Vdc, I _E = 0, T_A = 150°C)	ІСВО	DAY BUILD		10 10	nAdc μAdc
Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0)	IEBO			10	nAdc
ON CHARACTERISTICS					- No E
DC Current Gain ($I_C = 1.0 \ \mu Adc$, $V_{CE} = 5.0 \ Vdc$) ($I_C = 10 \ \mu Adc$, $V_{CE} = 5.0 \ Vdc$) ($I_C = 10 \ \mu Adc$, $V_{CE} = 5.0 \ Vdc$, $I_{CE} = 1.0 \ \mu Adc$) ($I_{CE} = 1$	hFE	30 100 20 175 200 250	190 250 40 275 300 350 400	500 - - - - 800	H ₃ 0
Collector-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 0.1 mAdc)	V _{CE(sat)}		0.25	0.35	Vdc
Base-Emitter On Voltage ($I_C = 0.1 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$)	V _{BE(on)}	0.5	0.65	0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C=0.05$ mAdc, $V_{CE}=5.0$ Vdc, $f=20$ MHz) ($I_C=0.5$ mAdc, $V_{CE}=5.0$ Vdc, $f=20$ MHz)	fΤ	15 60	50 100	_	MHz
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	-	3.0	6.0	pF
Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 1.0 MHz)	Cibo		4.0	6.0	pF
Input Impedance (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz)	h _{ie}	3.5	_	24	kΩ
Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz)	h _{re}	-1		800	x 10-6
Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = kHz)	h _{fe}	150	_	900	
Output Admittance (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz)	h _{oe}		_	40	μmhos
Noise Figure ($I_C = 10 \ \mu Adc$, $V_{CE} = 5.0 \ Vdc$, $R_S = 10 \ k\Omega$ $f = 100 \ Hz$, $BW = 20 \ Hz$) ($I_C = 10 \ \mu Adc$, $V_{CE} = 5.0 \ Vdc$, $R_S = 10 \ k\Omega$	NF	-	8.0	10	dB
f = 1.0 kHz, BW = 200 Hz) (I _C = 10 μAdc, V _{CE} = 5.0 Vdc, R _S = 10 kΩ f = 10 kHz, BW = 2.0 kHz)			-	3.0	
$(I_C = 10 \text{ kHz})$ $V_{CE} = 1.0 \text{ kHz}$ $V_{CE} = 1.0 \text{ kHz}$				3.0	

⁽¹⁾ R_{ØJA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Rating	Symbol	2N2895	2N2896	Unit
Collector-Emitter Voltage	VCEO	65	90	Vdc
Collector-Emitter Voltage	VCER	80	140	Vdc
Collector-Base Voltage	V _{CBO}	120	140	Vdc
Emitter-Base Voltage	V _{EBO}	7	.0	Vdc
Collector Current — Continuous	Ic	1.0		Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.5 2.86		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	P _D	1.8 10.3		Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200		°C

THERMAL CHARACTERISTICS

THE THINAL CHANACTERIOTICS			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	350	°C/W
Thermal Resistance, Junction to Case	$R_{\theta}JC$	97	°C/W

2N2895, 2N2896

CASE 22-03, STYLE 1
TO-18 (TO-206AA)

3 Collector

3 Emitter

GENERAL PURPOSE
TRANSISTORS

NPN SILICON

Refer to 2N3019 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Characteristic		Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I _C = 100 mAdc, R _{BE} = 10 ohms)	2N2895 2N2896	V(BR)CER	80 140	_	Vdc
Collector-Emitter Sustaining Voltage(1) (I _C = 100 mAdc, I _B = 0)	2N2895 2N2896	VCEO(sus)	65 90	_	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1 \text{ mAdc}, I_E = 0$)	2N2895 2N2896	V(BR)CBO	120 140	=	Vdc
Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0)		V(BR)EBO	7.0	_	Vdc
Collector Cutoff Current $(V_{CB} = 60 \text{ Vdc}, I_{C} = 0)$	2N2895 2N2896	ICBO	=	0.002 0.01	μAdc
$(V_{CB} = 60 \text{ Vdc}, I_{E} = 0, T_{A} = +150^{\circ}\text{C})$	2N2895		_	2.0	
$(V_{CB} = 90 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = 90 \text{ Vdc}, I_{E} = 0, T_{A} = +150^{\circ}\text{C})$	2N2896 2N2896		_	0.01 10	
Emitter Cutoff Current $(V_{EB} = 5.0 \text{ Vdc}, I_{C} = 0)$	2N2895 2N2896	I _{EBO}	=	0.005 0.01	μAdc
ON CHARACTERISTICS					
DC Current Gain $ \begin{aligned} &\text{(I}_C = 10 \; \mu\text{Adc, V}_{CE} = 10 \; \text{Vdc)} \\ &\text{(I}_C = 100 \; \mu\text{Adc, V}_{CE} = 10 \; \text{Vdc)} \\ &\text{(I}_C = 1.0 \; \text{mAdc, V}_{CE} = 10 \; \text{Vdc)} \\ &\text{(I}_C = 1.0 \; \text{mAdc, V}_{CE} = 10 \; \text{Vdc)} \\ &\text{(I}_C = 10 \; \text{mAdc, V}_{CE} = 10 \; \text{Vdc, T}_{A} = -55^{\circ}\text{C)} \end{aligned} $	2N2895 2N2895 2N2896 2N2895 2N2895,2N2896	hFE	10 20 35 35 20	= = = = = = = = = = = = = = = = = = = =	_
$(I_C = 150 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$	2N2895 2N2896		40 60	120 200	
(I _C = 500 mAdc, V _{CE} = 10 Vdc)(1)	2N2895		25	_	

FLECTRICAL	CHARACTERISTICS	(continued) (TA:	= 25°C unless	otherwise noted.)

Characteristic				Symbol	Min	Max	Unit
Collector-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc)	Vue	ONY	08	VCE(sat)	-	0.6	Vdc
Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 Adc)	pby		0.5	V _{BE} (sat)		1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS	pos		0.1	9	suon	nano) — saa	vii romano
Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	new		6.0	fT	120	E COLUMN AND IN	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	Vegato			C _{obo}	-	15	pF
Input Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz)		one	10.3	C _{ibo}	-	80	pF.d
Small-Signal Current Gain (IC = 5.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N2895 2N2896			h _{fe}	50 50	200 275	nasiaq a sT
Noise Figure (I _C = 0.3 mAdc, V _{CE} = 10 Vdc, R _S = 500 Ohms	, SN2895		Nex	NF	0,010	detroment.	dB
f = 1.0 kHz				Rata	neidmA ru t no	8.0	zikeR Ismier

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 1.8%.

PNP SILICON ANNULAR HERMETIC TRANSISTORS

... designed for high-speed switching circuits, DC to VHF amplifier applications and complementary circuitry.

- High DC Current Gain Specified 0.1 to 500 mAdc
- High Current-Gain Bandwidth Product —
 f_T = 200 MHz (Min) @ I_C = 50 mAdc
- Low Collector-Emitter Saturation Voltage $V_{CE(sat)} = 0.4 \text{ Vdc (Max)} @ I_C = 150 \text{ mAdc}$
- 2N2904, A thru 2N2907, A Complement to NPN 2N2218, A, 2N2219, A, 2N2221, A, 2N2222, A

MAXIMUM RATINGS

Rating	Symbol	Non-A Suffix	A-Suffix	Unit
Collector-Emitter Voltage	VCEO	- 40	-60	Vdc
Collector-Base Voltage	VCBO	-6	0	Vdc
Emitter-Base Voltage	VEBO	-5.	0	Vdc
Collector Current — Continuous	[⊕] IC	-60	00	mAdc
	(6)	2N2904,A 2N2905,A	2N2906,A 2N2907,A	2N2903
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	600	400 2.28	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	3.0 17.2	1.2 6.85	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-65 to	+200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol Max		Unit	
3g 15		2N2904,A; 2N2905,A	2N2906,A; 2N2907,A	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	292	438	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	58	146	°C/W

2N2904,A* thru 2N2907,A*

2N2904,A/2N2905,A CASE 79-04, STYLE 1 TO-39 (TO-205AD)



2N2906,A/2N2907,A CASE 22-03, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTORS

PNP SILICON

★2N2905A and 2N2907A are Motorola designated preferred devices.

ELECTRICAL CHARACTERISTICS	(T	=	25°C unless otherwise noted.)	į,
Cha	ract	eris	stic	

Character	ristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	41 .	(#51 mug(3)				emiT li
Collector-Emitter Breakdown Voltage(1) $(I_C = -10 \text{ mAdc}, I_B = 0)$	Non-A Suffix A-Suffix	V(BR)CEO	-40 -60	mi 000 ji ni quen <u>ça</u> at w	tt: Palet Vide ned <u>ec 1</u> ca Po	Vdc
Collector-Base Breakdown Voltage ($I_C = -$	$-10 \mu\text{Adc}$, I _E = 0)	V(BR)CBO	-60	_	_	Vdc
Emitter-Base Breakdown Voltage (IE $=$ $-$	10 μ Adc, I _C = 0)	V(BR)EBO	-5.0			Vdc
Collector Cutoff Current ($V_{CE} = -30 \text{ Vdc}$,	V _{EB} = -0.5 Vdc)	ICEX	_	-	-50	nAdc
Collector Cutoff Current (V _{CB} = -50 Vdc, I _E = 0) *	Non-A Suffix A-Suffix	ICBO	E	=	-0.02 -0.01	μAdc
$(V_{CB} = -50 \text{ Vdc}, I_{E} = 0, T_{A} = 150^{\circ}\text{C})$	Non-A Suffix A-Suffix		I		-20 -10	
Base Current ($V_{CE} = -30 \text{ Vdc}$, $V_{EB} = -60 \text{ Vdc}$	0.5 Vdc)	IB		_	-50	nAdc
ON CHARACTERISTICS		1177-1-4-				
DC Current Gain ($I_C = -0.1 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$)	2N2904, 2N2906 2N2905, 2N2907 2N2904A, 2N2906A 2N2905A, 2N2907A	hFE	20 35 40 75	=		-94 10

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

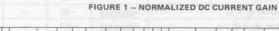
(continued)

2N2904, A THRU 2N2907, A

FI FCTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Cha	racteristic		Symbol	Min	Тур	Max	Unit
ON CHARACTERISTICS (continued)				dth Produc	hwhrasE -	nine)-detent	on Curr
DC Current Gain (IC = -1.0 mAdc, $V_{CE} = -10$ Vd	2N2905 2N2904	, 2N2906 , 2N2907 A, 2N2906A A, 2N2907A	e – ImAdo to NPN 2N22	25 50 40 100	(a) @ (g) (a) Satura (b) (Max) (907, A Co	Of Male (Note that the color of	1
$(I_C = -10 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})$	2N2905 2N2904	, 2N2906 , 2N2907 A, 2N2906A A, 2N2907A	Rivid A-mold	35 75 40 100	= 8	DIVIT - A M	UMDU
$(I_C = -150 \text{ mAdc}, V_{CE} = -10 \text{ Vo}$ $(I_C = -500 \text{ mAdc}, V_{CE} = -10 \text{ Vo}$	2N2905 dc)(1) 2N2904 2N2905 2N2904	,A, 2N2906,A ,A, 2N2907,A , 2N2906 , 2N2907 A, 2N2906A A, 2N2907A	h _{FE}	40 100 20 30 40 50	ayo uh line	120 300 — —	Hactor-Est Mitter-Basi Mactor C
Collector-Emitter Saturation Voltage ($I_C = -150$ mAdc, $I_B = -15$ mAd ($I_C = -500$ mAdc, $I_B = -50$ mAdc	dc)	Wen and	VCE(sat)	iū _d —	_ =	-0.4 -1.6	Vdc
Base-Emitter Saturation Voltage $(I_C = -150 \text{ mAdc}, I_B = -15 \text{ mAdc}, I_C = -500 \text{ mAdc}, I_B = -50 \text{ mAdc}, I_B = -50 \text{ mAdc}, I_B = -500 \text{ mAdc}$		1.2 Welfs	V _{BE} (sat)	G ⁹ _	_ //	-1.3 -2.6	Vdc
DYNAMIC CHARACTERISTICS		2.17m 01.0	2.17			- V- 970	the political
Current-Gain — Bandwidth Product((I _C = -50 mAdc, V _{CE} = -20 Vd		3 003 - 0	fT	200	nouseate	opna Tand	MHz
Output Capacitance (V _{CB} = -10 Vdc, I _E = 0, f = 1.0	MHz)	Ilau ysi	C _{ob}	Symbol	60/17 <u>21/1</u> 331 de	8.0	pF
Input Capacitance $(V_{EB} = -2.0 \text{ Vdc}, I_{C} = 0, f = 1.0)$	MHz)	ZNZRB6.A; ZNZRB7.A	C _{ib}	-	-	30	pF
SWITCHING CHARACTERISTICS		WOY BEA	292	Ross	enotion to	L., mornadela	aff lama
Turn-On Time (V	CC = -30 Vdc. I	c = -150 mAdc,	ton		26	45	ns
Delay Time	$I_{B1} = -1$	5 mAdc)	t _d	bua ^{PL}	6.0	10	A Ismit
Rise Time	(Figure	15a)	t _r		20	40	01
Turn-Off Time (Vo	$c_{C} = -6.0 \text{ Vdc. I}$	C = -150 mAdc,	toff	S = AT) 80	70	100	ns
Storage Time	I _{B1} = I _{B2} =	- 15 mAdc)	ts	itzhe t c ast	50	80	
Fall Time	(Figure	15b)	tf	_	20	30	RAKO S

⁽¹⁾ Pulse Test: Pulse Width $\leq 300~\mu s$, Duty Cycle $\leq 2.0\%$. (2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.



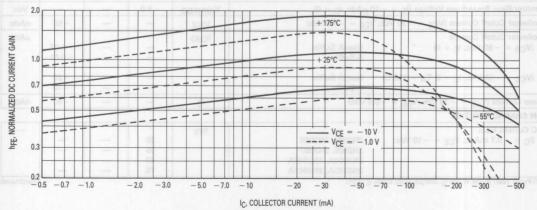
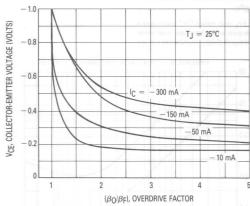
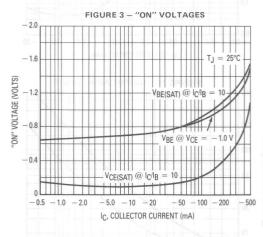


FIGURE 2 - NORMALIZED COLLECTOR SATURATION REGION





This graph shows the effect of base current on collector current. β_0 (current gain at edge of saturation) is the current gain of the transistor at 1 volt, and β_F (forced

gain) is the ratio of lc/lsr in a circuit.

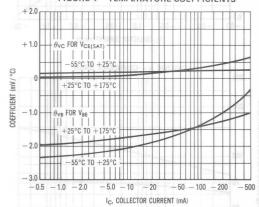
EXAMPLE: For type 2N2905, estimate a base current (IBF) to insure saturation at a temperature of 25°C

and a collector current of 150 mA.

Observe that at $I_c=150$ mA an overdrive factor of at least 3 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that $h_{\rm FE} \ @ 1$ volt is approximately 0.60 of $h_{\rm FE} \ @ 10$ volts. Using the guaranteed minimum of 100 @ 150 mA and 10 V, $\beta_0 = 60$ and substituting values in the overdrive equation, we find:

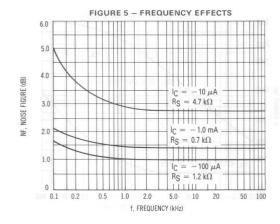
$$\frac{\beta_{\text{O}}}{\beta_{\text{F}}} = \frac{h_{\text{FE}} \ @ \ 1 \ V}{I_{\text{C}}/I_{\text{BF}}} \qquad \qquad 3 = \frac{60}{150/I_{\text{BF}}} \qquad \qquad I_{\text{BF}} \approx 7.5 \ \text{mA}$$

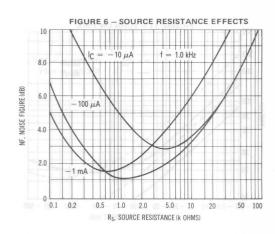
FIGURE 4 - TEMPERATURE COEFFICIENTS



SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE

 $V_{CE} = 10 \text{ V}, T_A = 25^{\circ}\text{C}$

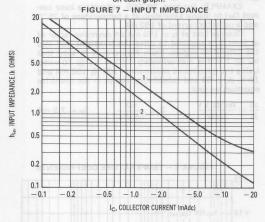


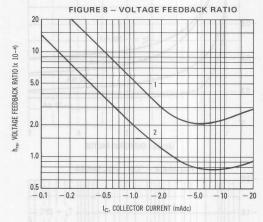


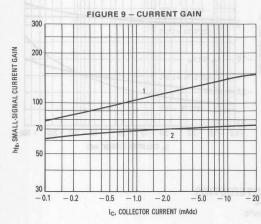
h PARAMETERS 100 033 JAMES 1 SANDO

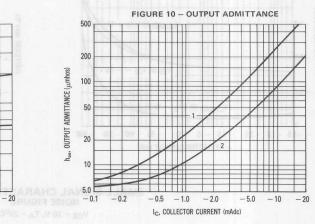
V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C

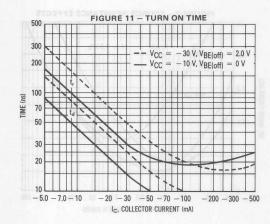
This group of graphs illustrates the relationship between high and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were selected and the same units were used to develop the correspondingly numbered curves on each graph.

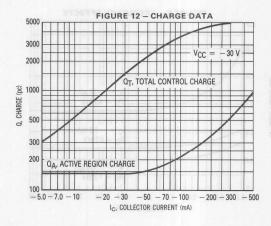




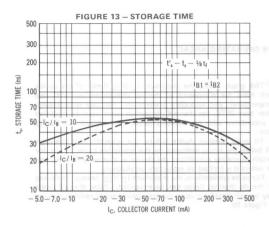


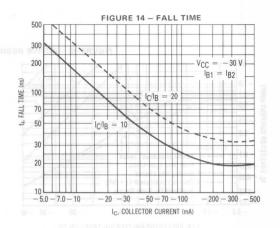


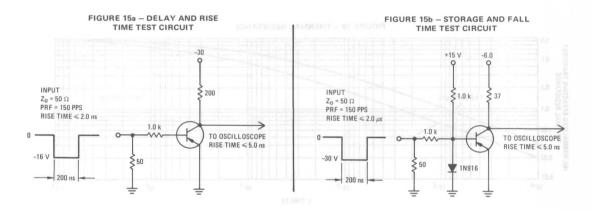


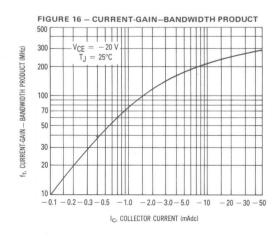


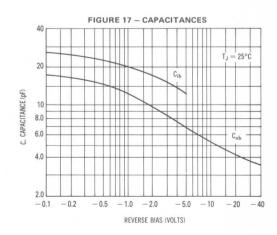
2N2904, A THRU 2N2907, A

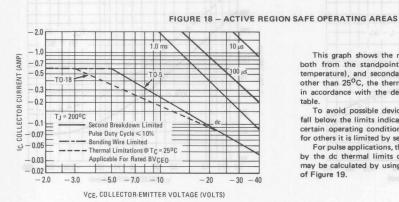










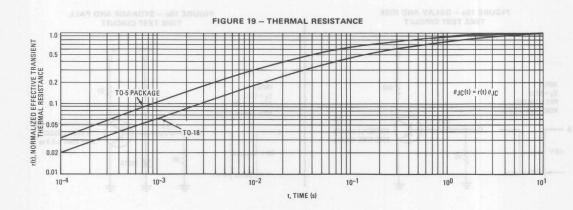


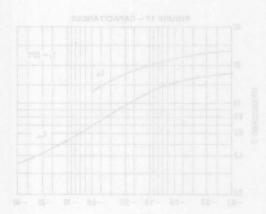
This graph shows the maximum I_C-V_{CE} limits of the device both from the standpoint of thermal dissipation (at 25°C case temperature), and secondary breakdown. For case temperatures other than 25°C , the thermal dissipation curve must be modified

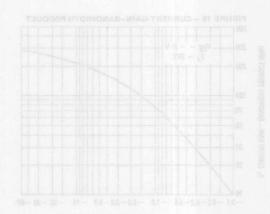
in accordance with the derating factor in the Maximum Ratings To avoid possible device failure, the collector load line must

fall below the limits indicated by the applicable curve. Thus, for certain operating conditions the device is thermally limited, and for others it is limited by secondary breakdown.

For pulse applications, the maximum I_C-V_{CE} product indicated by the dc thermal limits can be exceeded. Pulse thermal limits may be calculated by using the transient thermal resistance curve of Figure 19.







Rating	Symbol	2N3019 2N3020	2N3700	Unit
Collector-Emitter Voltage	VCEO	80	80	Vdc
Collector-Base Voltage	VCBO	140	140	Vdc
Emitter-Base Voltage	VEBO	7.0	7.0	Vdc
Collector Current — Continuous	IC	1.0	1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.8 4.6	0.5 2.85	Watts mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	5.0 28.6	1.8 10.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	- 65 to	o +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	2N3019 2N3020	2N3700	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	217	350	°C/W
Thermal Resistance, Junction to Case	R ₀ JC	35	97	°C/W

2N3019* 2N3020

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





2N3700*

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



GENERAL TRANSISTORS

NPN SILICON

★2N3019 and 2N3700 are Motorola designated preferred devices.

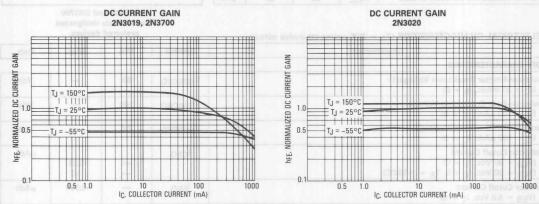
ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) Characteristic Symbol Max Unit OFF CHARACTERISTICS Collector-Emitter Breakdown Voltage(1) V(BR)CEO 80 Vdc $(I_C = 30 \text{ mAdc}, I_B = 0)$ Collector-Base Breakdown Voltage V(BR)CBO 140 Vdc $(I_C = 100 \, \mu Adc, I_E = 0)$ Emitter-Base Breakdown Voltage V(BR)EBO 7.0 Vdc $(I_F = 100 \, \mu Adc, I_C = 0)$ Collector Cutoff Current μAdc **ICBO** $(V_{CB} = 90 \text{ Vdc}, I_E = 0)$ 0.01 $(V_{CB} = 90 \text{ Vdc}, I_{E} = 0, T_{A} = +150^{\circ}\text{C})$ 10 **Emitter Cutoff Current** 0.010 μAdc **IEBO** $(V_{EB} = 5.0 \text{ Vdc}, I_{C} = 0)$ ON CHARACTERISTICS DC Current Gain hFE 2N3700, 2N3019 $(I_C = 0.1 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ 50 2N3020 30 100 2N3700, 2N3019 $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$ 90 2N3020 40 120 $(I_C = 150 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$ 2N3700, 2N3019 100 300 2N3020 40 120 2N3700, 2N3019 $(I_C = 150 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, T_C = -55^{\circ}C)(1)$ 40 $(I_C = 500 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$ 2N3700, 2N3019 50 2N3020 30 100 $(I_C = 1.0 \text{ Adc}, V_{CE} = 10 \text{ Vdc})(1)$ All Types 15 Collector-Emitter Saturation Voltage(1) Vdc VCE(sat) ($I_C = 150 \text{ mAdc}$, $I_B = 15 \text{ mAdc}$) ($I_C = 500 \text{ mAdc}$, $I_B = 50 \text{ mAdc}$) 0.2 0.5 Base-Emitter Saturation Voltage(1) V_{BE}(sat) 1.1 Vdc $(I_C = 150 \text{ mAdc}, I_B = 15 \text{ mAdc})$ **SMALL-SIGNAL CHARACTERISTICS** Current-Gain — Bandwidth Product fT MHz (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz) 2N3020 80 2N3019, 2N3700 100 400

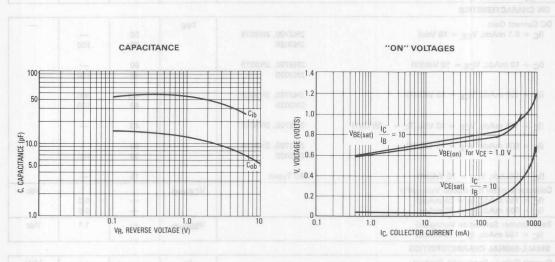
2N3019 2N3020 2N3700

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic			expelies	Symbol	Min	Max	Unit
Output Capacitance				Cobo		12	pF
$(V_{CB} = 10 \text{ Vdc}, I_{E} = 0, f = 1.0 \text{ MHz})$	bliv	.08	08	ОвоМ		apridioV ret	lector-Emil
(V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) 2N3700, 2N3019 2N3020				Cibo		60	pF
	Sand I		in terretical	202000			
Small-Signal Current Gain				h _{fe}	201000	mon 3 Ine	hed at Con
$(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc}, f = 1.0 \text{ kHz})$	-	2N3700, 2N	3019	- V	80	400	1000
A / 1983	Water	2N3020	0.8	09	30	200	Jeolyeti In
Collector Base Time Constant				rb'C _c		2,02 6	ps
(IE = 10 mAdc, VCB = 10 Vdc, f = 79.8 MHz)	ETERVY :	2N3019, 2N	3020	139	7 = 25 K	400	al-Device S
Ollector Base Time Constant (IE = 10 mAdc, V _{CB} = 10 Vdc, f = 79.8 MHz) 2N3019, 2N3020 2N3700		15	400	voda statel			
Noise Figure	01	1 200	ar 80 -	NF	_eaftan	4 18	dB
$(I_C = 100 \mu Adc, V_{CE} = 10 Vdc,$		2N3019,				Bange .	emperatur
$R_S = 1.0 \text{ k ohms}, f = 1.0 \text{ kHz}$		2N3700					

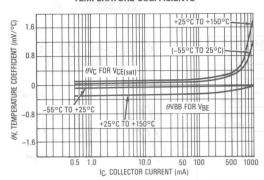
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 1.0%.



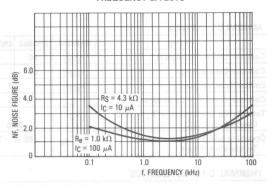


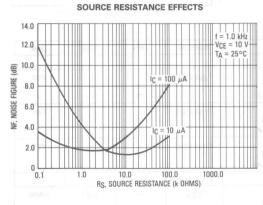
2N3019 2N3020 2N3700



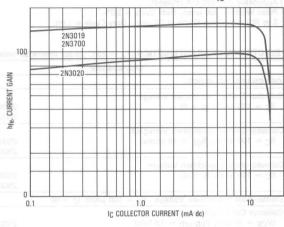


FREQUENCY EFFECTS

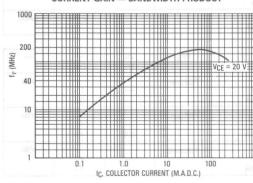




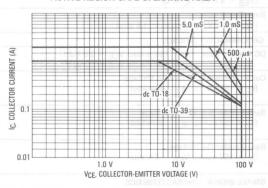
CURRENT GAIN BANDWIDTH PRODUCT versus COLLECTOR CURRENT — 1 kHz hfe



CURRENT GAIN — BANDWIDTH PRODUCT



ACTIVE REGION SAFE OPERATING AREA



Rating	Symbol	2N3053	2N3053A	Unit
Collector-Emitter Voltage(1)	VCEO	40	60	Vdc
Collector-Base Voltage	V _{CBO}	60	80	Vdc
Emitter-Base Voltage	VEBO	5	.0	Vdc
Collector Current — Continuous	Ic	700		mAdc
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD		5.0 8.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	- 65 t	o +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	R _O JC	35	°C/W

(1) Applicable 0 to 100 mA (Pulsed):

Pulse Width \leq 300 μ sec., Duty Cycle \leq 2.0%. 0 to 700 mA; Pulse Width \leq 10 μ sec., Duty Cycle \leq 2.0%.

2N3053, A

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to 2N3019 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	- 17 VI = 1	Symbol	Min	Max	Unit
OFF CHARACTERISTICS					11/10
Collector-Emitter Breakdown Voltage (IC = 100 μ Adc, IB = 0)	2N3053 2N3053A	V(BR)CEO	40 60	=	Vdc
Collector-Emitter Breakdown Voltage(2) (I _C = 100 mAdc, R _{BE} = 10 ohms)	2N3053 2N3053A	V(BR)CER	50 70	1	Vdc
Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0)	2N3053 2N3053A	V(BR)CBO	60 80	E	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \mu Adc, I_C = 0$)	10	V(BR)EBO	5.0	E 100 - 101	Vdc
Collector Cutoff Current (V _{CE} = 30 Vdc, V _{EB(off)} = 1.5 Vdc) (V _{CE} = 60 Vdc, V _{EB(OFF)} = 1.5 Vdc)	2N3053 2N3053A	ICEX		0.25	μAdc
Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0)	2N3053	IEBO	IN — BAND	0.25	μAdc
Base Cutoff Current (VCE = 60 Vdc, VEB(off) = 1.5 Vdc)	2N3053 2N3053A	I _{BL}		0.25	μAdc
ON CHARACTERISTICS(2)					III ms
DC Current Gain ($I_C = 150 \text{ mAdc}$, $V_{CE} = 2.5 \text{ Vdc}$) ($I_C = 150 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$)	3 4 4 5 5 5	hFE	25 50	 250	III -
Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc)	2N3053 2N3053A	VCE(sat)		1.4 0.3	Vdc
Base-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc)	2N3053 2N3053A	V _{BE} (sat)	 0.6	1.7 1.0	Vdc
Base-Emitter On Voltage (I _C = 150 mAdc, V _{CE} = 2.5 Vdc)	2N3053 2N3053A	V _{BE} (on)	THE TANK	1.7 1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 1	10 Vdc, f = 100 MHz)	fT	100		MHz
Output Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_{E} = 0$, $f = 1.0 \text{ MHz}$)		C _{obo}		15	pF
Input Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz)		Cibo		80	pF

(2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Characteristic	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-40	Vdc
Collector-Base Voltage	V _{CBO}	-40	Vdc
Emitter-Base Voltage	V _{EBO}	-5.0	Vdc
Collector Current — Continuous	IC	-1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 5.71	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.175	°C/mW
Thermal Resistance, Junction to Case	$R_{\theta}JC$	35	°C/W

2N3244

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





GENERAL PURPOSE TRANSISTOR

PNP SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

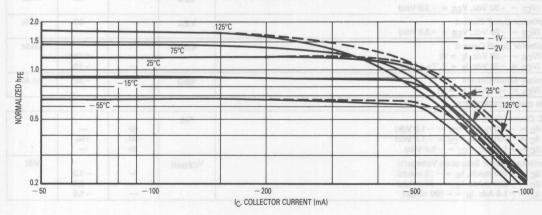
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS		has her derror	20, 100	1901) 5-11
Collector-Emitter Breakdown Voltage(1) (I _C = -10 mAdc, I _B = 0)	V _(BR) CEO	-40	_	Vdc
Collector-Base Breakdown Voltage (IC = -10 µAdc, IE = 0)	V(BR)CBO	-40	_	Vdc
Emitter-Base Breakdown Voltage (I _E = -10 µAdc, I _C = 0)	V(BR)EBO	-5.0	_	Vdc
Base Cutoff Current (VCE $= -30$ Vdc, VEB $= -3.0$ Vdc)	IBEV	_	-80	nAdc
Collector Cutoff Current ($V_{CE} = -30 \text{ Vdc}$, $V_{EB} = -3.0 \text{ Vdc}$)	ICEX		-50	nAdc
Collector Cutoff Current $(V_{CB} = -30 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = -30 \text{ Vdc}, I_{E} = 0, T_{A} = 100^{\circ}\text{C})$	ІСВО		-0.050 -10	μAdc
Emitter Cutoff Current (VEB = -4.0 Vdc, I _C = 0)	IEBO	781	-30	nAdc
ON CHARACTERISTICS			000-	
DC Current Gain(1) $(I_C = -150 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})$ $(I_C = -500 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})$ $(I_C = -1.0 \text{ Adc}, V_{CE} = -5.0 \text{ Vdc})$	hFE	60 50 25	 150 	- 3- 3
Collector-Emitter Saturation Voltage(1) $ \begin{aligned} &(I_C = -150 \text{ mAdc}, I_B = -15 \text{ mAdc}) \\ &(I_C = -500 \text{ mAdc}, I_B = -50 \text{ mAdc}) \\ &(I_C = -1.0 \text{ Adc}, I_B = -100 \text{ mAdc}) \end{aligned} $	VCE(sat)	131	-0.3 -0.5 -1.0	Vdc

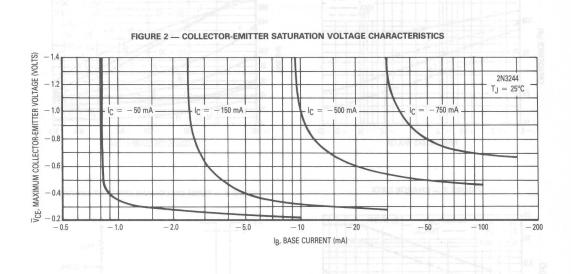
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

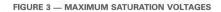
	Characteristic			Symbol	Min	Max	Unit
Base-Emitter Saturation Voltage(1) (I _C = -150 mAdc, I _B = -15 mAdc)		Vdc	00-	V _{BE} (sat)	_	-1.1	Vdc
$(I_C = -500 \text{ mAdc})$				Veso	-0.75	-1.5	Heatan Bas
$(I_C = -1.0 \text{ Adc}, I_B = -100 \text{ mAdc})$ $(I_C = -750 \text{ mA}, I_B = -75 \text{ mA})$				onaV		-2.0 -2.0	nitter-Base
SMALL-SIGNAL CHA	RACTERISTICS	DERM			1000	Humby Hill	Principal Rezugation
Current-Gain — Band (I _C = -50 mAdc,	dwidth Product VCE = -10 Vdc, f = 100 MHz)			fT	175		MHz
Output Capacitance (V _{CB} = -10 Vdc,	l _E = 0, f = 100 kHz)	DOWN:	28.6	C _{obo}	247-2	25	pF
Input Capacitance (V _{EB} = -0.5 Vdc,	I _C = 0, f = 100 kHz)		Luck of the	C _{ibo}	-	100	pF
SWITCHING CHARAC	CTERISTICS				00110	ing) garage	o president
Delay Time	$(I_C = -500 \text{ mA}, I_{B1} = -$	-50 mA	Barre	t _d		15	ns
Rise Time	$V_{BE} = +2.0 \text{ V, } V_{CC} = -$	30 V)		t _r	HOLINA CO HO	35	ns
Storage Time		$(I_C = -500 \text{ mA}, V_{CC} = -30 \text{ V}$ $I_{B1} = I_{B2} = -50 \text{ mA})$		t _S	8885 EV 40	140	ns
Fall Time	$I_{B1} = I_{B2} = -50 \text{ mA}$			tf		45	ns
Total Control Charge (I _C = -500 mA, I _B = -50 mA, V _{CC} = -30 V)		От	n acmain	14	nC		

⁽¹⁾ Pulse Test: PW \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 — MINIMUM CURRENT GAIN CHARACTERISTICS







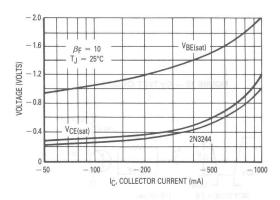


FIGURE 4 — TYPICAL TEMPERATURE COEFFICIENTS

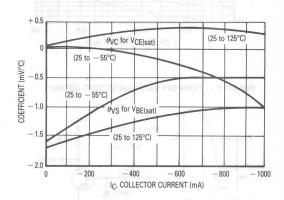


FIGURE 5 — JUNCTION CAPACITANCE

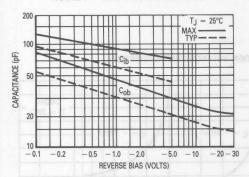


FIGURE 6 — TYPICAL SWITCHING TIMES

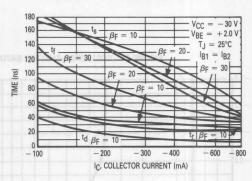


FIGURE 7 — CHARGE DATA

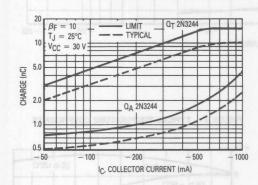


FIGURE 8 — TURN-ON EQUIVALENT TEST CIRCUIT

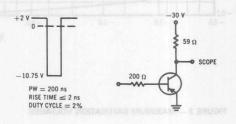


FIGURE 9 — TURN-OFF EQUIVALENT TEST CIRCUIT

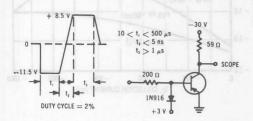


FIGURE 10 - QT TEST CIRCUIT

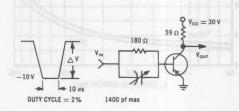
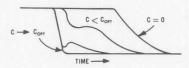


FIGURE 11 — TURN-OFF WAVEFORM



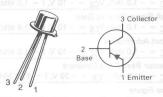
THE PRINCE OF TH	traction wild			
Rating	Symbol	2N3250 2N3251	2N3251A	Unit
Collector-Emitter Voltage	VCEO	-40	-60	Vdc
Collector-Base Voltage	VCBO	-50	-60	Vdc
Emitter-Base Voltage	VEBO	_	5.0	Vdc
Collector Current 001	Ic	-200		mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.36 2.06		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.2 6.9		Watts mW/°C
Operating and Storage Temperature Temperature Range	TJ, T _{stg}	-65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	486	°C/W
Thermal Resistance, Junction to Case	R ₀ JC	146	°C/W

2N3250 2N3251,A*

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

★2N3251A is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit	
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) (I _C = -10 mAdc)	2N3250, 2N 2N3251A	N3251	V _(BR) CEO	-40 -60	_	Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc$)	2N3250, 2l 2N3251A	N3251	V _(BR) CBO	-50 -60	_	Vdc
Emitter-Base Breakdown Voltage IF = $-10 \mu Adc$)				-5.0	I SNUDH	Vdc
Collector Cutoff Current (V _{CE} = -40 Vdc, V _{EB} = -3.0 Vdc)		25°C	ICEX		-20	nA
Base Cutoff Current (V _{CE} = -40 Vdc, V _{EB} = -3.0 Vdc)		161 01 -	IBL		-50	nAdc
ON CHARACTERISTICS						
DC Forward Current Transfer Ratio ($I_C = -0.1 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$)	2N3250 2N3251, 2l	N3251A	hFE	40 80	(7)	001
$(I_C = -1.0 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})$	2N3250 2N3251, 2I	N3251A	L- = 00V 31 d	45 90	17	
$(I_C = -10 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})(1)$	2N3250 2N3251, 2l	N3251A		50 100	150 300	- 08
$(I_C = -50 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})(1)$	2N3250 2N3251, 2I	N3251A	201	15 30	=	
Collector-Emitter Saturation Voltage (1) (I _C = -10 mAdc, I _B = -1.0 mAdc) (I _C = -50 mAdc, I _B = -5.0 mAdc	30		VCE(sat)		-0.25 -0.5	Vdc
Base-Emitter Saturation Voltage (1) ($I_C = -10$ mAdc, $I_B = -1.0$ mAdc) ($I_C = -50$ mAdc, $I_B = -5.0$ mAdc)			V _{BE(sat)}	- 0.6 	-0.9 -1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS						
			fT	250 300	<u> </u>	MHz
Output Capacitance (V _{CB} = -10 Vdc, I _E = 0, f = 1.0 MHz)			C _{obo}	COLLECTOR	6.0	pF
Input Capaciatance (V _{EB} = -1.0 Vdc, I _C = 0, f = 1.0 MHz)			C _{ibo}	_	8.0	pF

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

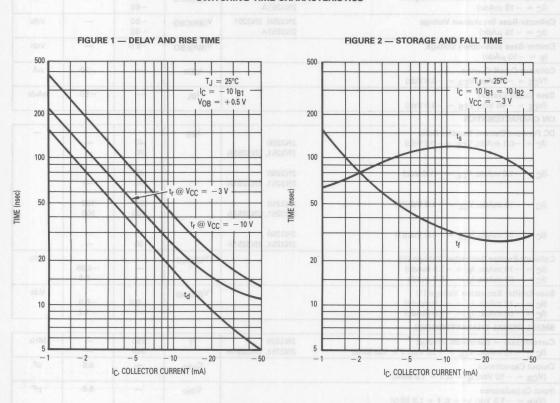
Characteristic			Symbol	Min	Max	Unit
Input Impedance (I _C = -1.0 mA, V _{CE} = -10 V, f = 1.0 kHz)	Unit	2N3250 2N3251, 2N3251A	h _{ie}	1.0 2.0	6.0 12	kohms
Voltage Feedback Ratio (I _C = -1.0 mA, V _{CE} = -10 V, f = 1.0 kHz)	obV.	2N3250 2N3251, 2N3251A	h _{re}	=	10 20	X 10-4
Small-Signal Current Gain (I _C = -1.0 mA, V _{CE} = -10 V, f = 1.0 kHz)	bAm	2N3250 2N3251, 2N3251A	h _{fe}	50 100	200 400	nitt er Base Seetne Con
Output Admittance (I _C = -1.0 mA, V _{CE} = -10 V, f = 1.0 kHz)	teVV	2N3250 2N3251, 2N3251A	h _{oe}	4.0	40 60	μmhos
Collector Base Time Constant (I _C = -10 mA, V _{CE} = -20 V, f = 31.8 MHz)	StaVV	\$.7	rb'CC	7°65 = 25°C	250	ps
Noise Figure (I _C = $-100~\mu$ A, V _{CE} = $-5.0~\text{V}$, R _S = $1.0~\text{k}\Omega$, f = $100~\text{k}\Omega$	Hz)	-65 to +200	NF.	sn/Jurenn	6.0	dB

SWITCHING CHARACTERISTICS

Characteristic			Symbol	Max	Unit
Delay Time		Symbol Max	t _d	35	ns
Rise Time	$I_C = -10 \text{ mAdc}, I_{B1} = -1.0 \text{ mA})$		naidmt _r or noi	35	ns
Storage Time	Time $I_C = -10 \text{ mAdc}, I_{B1} = I_{B1} = -1.0 \text{ mAdc}$ 2N3250 (V _{CC} = -3.0 V) 2N3251, 2N3251A		t _S	175 200	ns ns
Fall Time			tf	50	ns

(1) Pulse Test: PW = 300 μ s, Duty Cycle = 2.0%.

SWITCHING TIME CHARACTERISTICS



AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

 $(V_{CE} = 6.0 \text{ V}, T_{A} = 25^{\circ}\text{C})$

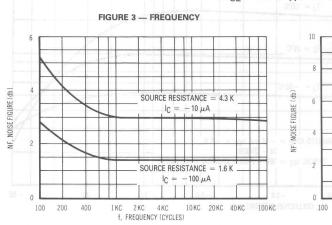
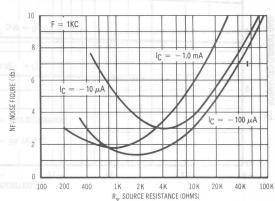


FIGURE 4 — SOURCE RESISTANCE



h PARAMETERS

 $V_{CE} = 10 \text{ V, f} = 1.0 \text{ kc, T}_{A} = 25^{\circ}\text{C}$

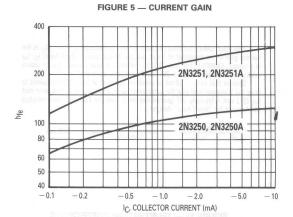
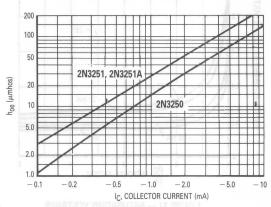
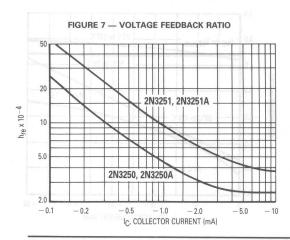


FIGURE 6 — OUTPUT ADMITTANCE





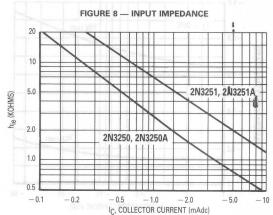


FIGURE 9 — NORMALIZED CURRENT GAIN CHARACTERISTICS

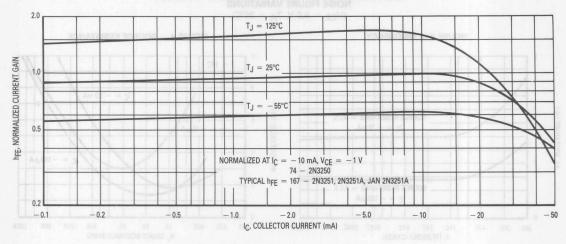
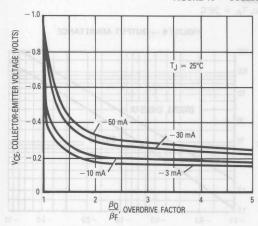


FIGURE 10 — COLLECTOR SATURATION REGION



This graph shows the effect of base current on collector current. β_0 is the

In sgraph shows the effect of base current on collector current. $P_{\rm s}$ is the current gain of the transistor at 1 volt, and $P_{\rm F}$ (forced gain) is the ratio of $I_{\rm C}/I_{\rm BF}$ in a circuit. EXAMPLE: For type 2N3251, estimate a base current ($I_{\rm BF}$) to insure saturation at a temperature of 25°C and a collector current of 10 mA. Observe that at $I_{\rm C}=10$ mA an overdrive factor of at least 2.5 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that $I_{\rm FE}$ ($I_{\rm BF}$) 1 volt is typically 167 (guaranteed limits from the Table of Characteristics can be used for "worst-case" design).

$$\frac{\beta_{\rm O}}{\beta_{\rm F}} = \frac{\rm h_{\rm FE} @~1~Volt}{\rm I_{\rm C}/I_{\rm BF}} \qquad 2.5 = \frac{167}{10~{\rm mA/I_{\rm BF}}} \qquad \rm I_{\rm BF} \approx -6.68~mA$$

FIGURE 11 — SATURATION VOLTAGES

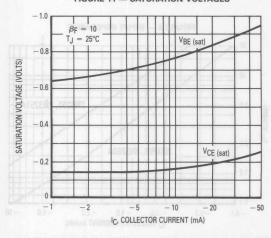
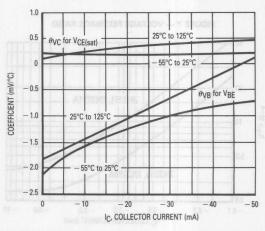


FIGURE 12 — TEMPERATURE COEFFICIENTS



2N3250 2N3251,A

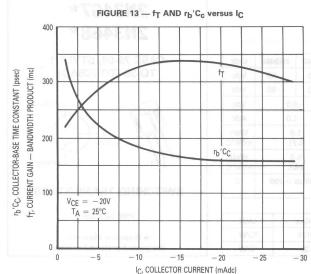


FIGURE 14 — 30 MC EQUIVALENT CIRCUIT

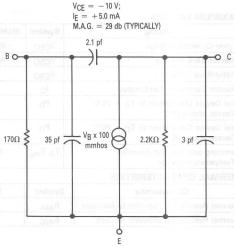


FIGURE 15 — JUNCTION CAPACITANCE

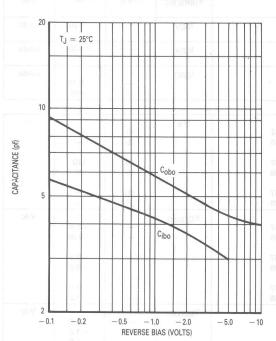
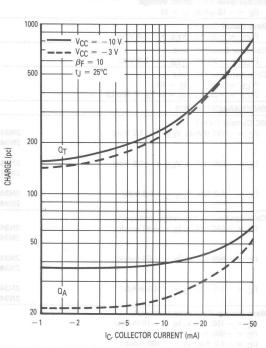


FIGURE 16 — CHARGE DATA



Rating	Symbol	2N3467	2N3468	Unit
Emitter-Collector Voltage	VCEO	-40	-50	Vdc
Collector-Base Voltage	VCBO	-40	-50	Vdc
Emitter-Base Voltage	VEBO		5.0	Vdc
Collector Current — Continuous	Ic	- 1.0		Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 5.71		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	5.0 28.6		Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to	-65 to +200	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W

∠n340/ ^ 2N3468*

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





SWITCHING TRANSISTORS

PNP SILICON

★These are Motorola designated preferred devices.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS		ACAMO NASA			
Collector-Emitter Breakdown Voltage(1) (I _C = -10 mAdc, I _B = 0)	2N3467 2N3468	V(BR)CEO	-40 -50	=	Vdc
Collector-Base Breakdown Voltage (IC = $-10 \mu Adc$, IE = 0)	2N3467 2N3468	V(BR)CBO	-40 -50	=	Vdc
Emitter-Base Breakdown Voltage $(I_E = -10 \mu Adc, I_C = 0)$		V _{(BR)EBO}	-5.0	SENUENS	Vdc
Base Cutoff Current (V _{CE} = -30 Vdc, V _{EB} = -3.0 Vdc)		IBEV	HTH	-120	nAdc
Collector Cutoff Current (VCE = -30 Vdc, VEB = -3.0 Vdc)		ICEX		-100	nAdc
Collector Cutoff Current $(V_{CB} = -30 \text{ Vdc}, I_E = 0)$ $(V_{CB} = -30 \text{ Vdc}, I_E = 0, T_A = 100^{\circ}\text{C})$	68	ICBO	_	-0.10 -15	μAdc
ON CHARACTERISTICS					Of .
DC Current Gain(1) (I _C = -150 mAdc, V _{CE} = -1.0 Vdc)	2N3467 2N3468	hFE	40 25		4 -
$(I_C = -500 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc})$	2N3467 2N3468	1	40 25	120 75	
$(I_{C} = -1.0 \text{ Adc}, V_{CE} = -5.0 \text{ Vdc})$	2N3467 2N3468		40 20		
Collector-Emitter Saturation Voltage(1) (I _C = -150 mAdc, I _B = -15 mAdc)	2N3467 2N3468	VCE(sat)	Ī	-3.0 -0.36	Vdc
$(I_C = -500 \text{ mAdc}, I_B = -50 \text{ mAdc})$	2N3467 2N3468		=	-0.5 -0.6	
$(I_C = -1.0 \text{ Adc}, I_B = -100 \text{ mAdc})$	2N3467 2N3468		=	-1.0 -1.2	
Base-Emitter Saturation Voltage(1) (IC = -150 mAdc, IB = -15 mAdc) (IC = -500 mAdc, IB = -50 mAdc) (IC = -1.0 Adc, IB = -100 mAdc)	1- 01-	VBE(sat)		-1.0 -1.2 -1.6	Vdc

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

	Characteristic		Symbol	Min	Max	Unit		
SMALL-SIGNAL C	HARACTERISTICS							
Current-Gain — B (I _C = -50 mAc	andwidth Product c, V _{CE} = -10 Vdc, f = 100 MHz)	2N3467 2N3468	fT	175 150		MHz		
Output Capacitano (V _{CB} = -10 Vo	ce lc, I _E = 0, f = 100 kHz)	28 - 17	C _{obo}		25	pF		
Input Capacitance (V _{EB} = -0.5 V	dc, I _C = 0, f = 100 kHz)		C _{ibo}	-	100	pF		
SWITCHING CH	ARACTERISTICS					-		
Delay Time	$(I_C = -500 \text{ mA}, I_{B1} = -50)$		t _d	-	10	ns		
Rise Time	2.0 V, V _{CC} = 30 V)	0.69 - = 0	t _r	i -	30	ns		
Storage Time	(Ic = -500 mA Int = Inc =	-50 mA Vcc = -30 V)	ts		60	ns		
Fall Time	11C = 300 HIA, IB1 = IB2 =	181 - 18520 HIM' ACC = -20 A)		$(I_C = -500 \text{ mA}, I_{B1} = I_{B2} = -50 \text{ mA}, V_{CC} = -30 \text{ V})$	tf		30	ns
Total Control Cha	rge B = 50 mA, V _{CC} = 30 V)		Оτ		6.0	nC		

⁽¹⁾ Pulse Test: PW \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 — STORAGE TIME VARIATION WITH TEMPERATURE

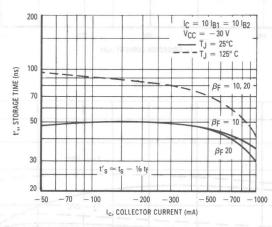
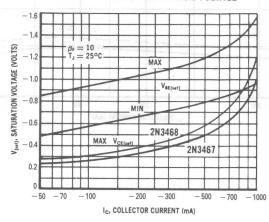
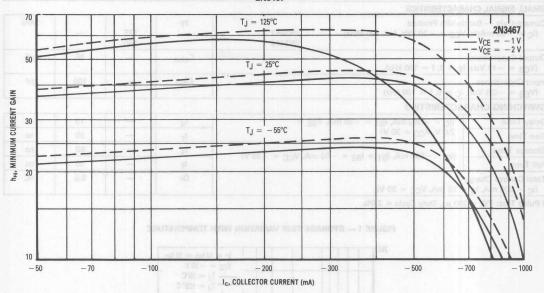


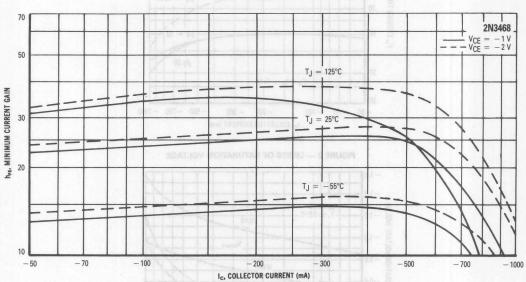
FIGURE 2 — LIMITS OF SATURATION VOLTAGE







2N3468



Rating	Symbol	Value	Unit
Emitter-Collector Voltage	VCEO	-120	Vdc
Collector-Base Voltage	VCBO	-120	Vdc
Emitter-Base Voltage	VEBO	-4.5	Vdc
Collector Current — Continuous	lc	-100	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	400 2.28	mW mW/°C
Total Device Dissipation @ T _C = 25°C* Derate above 25°C	P _D	1.2 6.85	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

^{*}Indicates Data in addition to JEDEC Requirements.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	R ₀ JA	486	°C/W
Thermal Resistance, Junction to Case	R ₀ JC	146	°C/W

2N3497





CASE 22-03, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTORS

PNP SILICON

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	1000 200 TE		-	1.00
Collector-Emitter Breakdown Voltage(1) (IC = -10 mAdc, IB = 0)	V(BR)CEO	-120	-	Vdc
Collector-Base Breakdown Voltage (I _C = -10 µAdc, I _E = 0)	V _(BR) CBO	-120		Vdc
Emitter-Base Breakdown Voltage (I _E = -10 µAdc, I _C = 0)	V(BR)EBO	-4.5	S SPLUTION	Vdc
Collector Cutoff Current (V _{CB} = -90 Vdc, I _E = 0)	Ісво		-100	nAdc
Emitter Cutoff Current (VEB = -3.0 Vdc, I _C = 0)	IEBO		-25	nAdc
ON CHARACTERISTICS	10000 - 1000			₽ 8.0- S
DC Current Gain(1) $ \begin{aligned} &(I_{\text{C}} = -100 \ \mu\text{Adc}, \text{V}_{\text{CE}} = -10 \ \text{Vdc}) \\ &(I_{\text{C}} = -10 \ \text{mAdc}, \text{V}_{\text{CE}} = -10 \ \text{Vdc}) \\ &(I_{\text{C}} = -10 \ \text{mAdc}, \text{V}_{\text{CE}} = -10 \ \text{Vdc}) \\ &(I_{\text{C}} = -50 \ \text{mAdc}, \text{V}_{\text{CE}} = -10 \ \text{Vdc}) \end{aligned} $	hFE	35 40 40 40		TCO POLICE
Collector-Emitter Saturation Voltage (IC = -10 mAdc, IB = -1.0 mAdc)	VCE(sat)		-0.35	Vdc
Base-Emitter Saturation Voltage (IC = -10 mAdc, IB = -1.0 mAdc)	V _{BE} (sat)	-0.6	-0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS	- Laurence	A SE	0.50%	
Current-Gain — Bandwidth Product(2) (I _C = -20 mAdc, V _{CE} = -10 Vdc, f = 100 MHz)	fT -	150	330	MHz
Output Capacitance (V _{CB} = -10 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	July AT	6.0	pF
Input Capacitance (VEB = -2.0 Vdc, I _C = 0, f = 1.0 MHz)	C _{ibo}		30	pF
Input Impedance (IC = -10 mAdc, VCE = -10 Vdc, f = 1.0 kHz)	H _{ie}	0.1	1.2	k ohms
Voltage Feedback Ratio (I _C = -10 mAdc, V _{CE} = -10 Vdc, f = 1.0 kHz)	h _{re}		2.0	X 10-4
Small-Signal Current Gain ($I_C = -10 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h _{fe}	40	300	
		71117171	1	1

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
Output Admittance (I _C = -10 mAdc, V _{CE} = -10 Vdc, f = 1.0 kHz)	3.1-	h _{oe}	_	300	μ mhos
Real Part of Input Impedance	007-	Re(hie)	- Enon	30	Ohms
$(I_C = -20 \text{ mAdc}, V_{CE} = -10 \text{ Vdc}, f = 300 \text{ MHz})$		169		D neitaglassi.	solveQ Islo

SWITCHING CHARACTERISTICS

Turn-On Time ($V_{CC} = -30 \text{ Vdc}$, $I_{C} = -10 \text{ mAdc}$, $I_{B1} = -1.0 \text{ mAdc}$)	ton	*378 <u>*</u> =3T	300	ns
Turn-Off Time ($V_{CC} = -30$ Vdc, $I_{C} = -10$ mAdc, $I_{B1} = I_{B2} = -1.0$ mAdc)	toff	-noitor	1000	ns

⁽¹⁾ Pulse Test: Pulse Width ≤300 µs, Duty Cycle = 2.0%.

FIGURE 1 - TURN-ON TIME TEST CIRCUIT

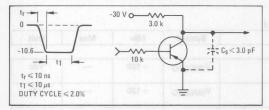
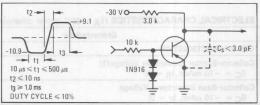
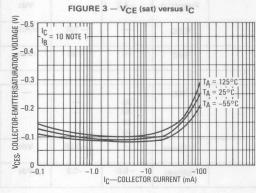
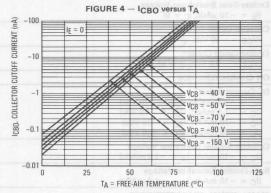
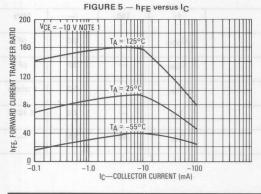


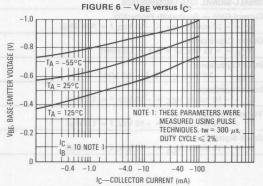
FIGURE 2 – TURN-OFF TIME TEST CIRCUIT



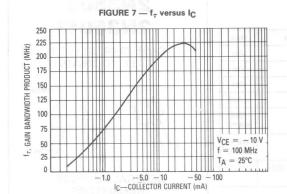


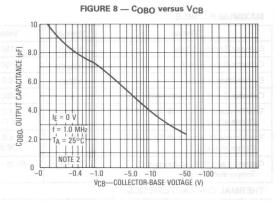


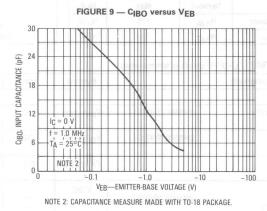




⁽²⁾ fT is defined as the frequency at which hfe extrapolates to unity.







Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	150	Vdc
Collector-Base Voltage	VCBO	150	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	Ic	300	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 5.71	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	R ₀ JA	175	°C/W
Thermal Resistance, Junction to Case	ReJC	35	°C/W

2N3500 2N3501*

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





GENERAL PURPOSE TRANSISTORS

NPN SILICON

★2N3501 is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

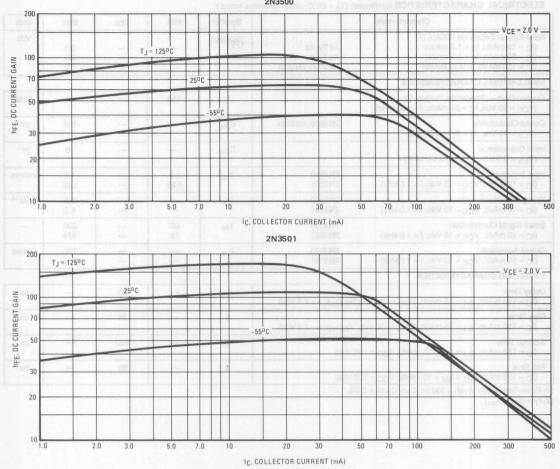
Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS			5			
Collector-Emitter Breakdown Voltage (1) (I _C = 10 mAdc, I _B = 0)	2N3500, 2N3501	V(BR)CEO	150	-		Vdc
Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0)	2N3500, 2N3501	V _(BR) CBO	150	-	-	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)	AL MADE DE MET	V _{(BR)EBO}	6.0			Vdc
Collector Cutoff Current (V _{CB} = 75 Vdc, I _E = 0) (V _{CB} = 75 Vdc, I _E = 0, T _A = 150°C)	2N3500, 2N3501	ІСВО	o =	Ξ	0.05 50	μAdc
Emitter Cutoff Current (VEB(off) = 4.0 Vdc, IC = 0)		IEBO		-	25	nAdc
ON CHARACTERISTICS						
DC Current Gain ($I_C = 0.1 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$) ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$)	2N3500 2N3501 2N3500 2N3501	hFE	20 35 25 50 35	= = =	Ξ	-
(I _C = 10 mAdc, V_{CE} = 10 Vdc) (1) (I _C = 150 mAdc, V_{CE} = 10 Vdc) (1)	2N3500 2N3501 2N3500		75 40 100	=	120 300	
(I _C = 300 mAdc, V _{CE} = 10 Vdc) (1)	2N3501 2N3500 2N3501		15 20	=	=	
Collector-Emitter Saturation Voltage (1) ($I_C = 10 \text{ mAdc}$, $I_B = 1.0 \text{ mAdc}$) ($I_C = 50 \text{ mAdc}$, $I_B = 5.0 \text{ mAdc}$) ($I_C = 150 \text{ mAdc}$, $I_B = 15 \text{ mAdc}$)	All Types All Types 2N3500, 2N3501	VCE(sat)	Ξ	=	0.2 0.25 0.4	Vdc

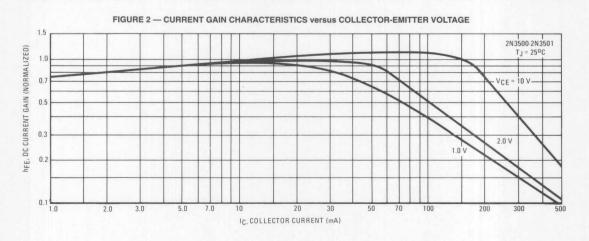
ELECTRICAL CHARACTERISTICS (continued) ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
Base-Emitter Saturation Voltage (1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) (I _C = 150 mAdc, I _B = 15 mAdc)	All Types All Types 2N3500, 2N3501	VBE(sat)		- <u>-</u>	0.8 0.9 1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS						- 0
Current-Gain — Bandwidth Product (2) (V _{CE} = 20 Vdc, I _C = 20 mAdc, f = 100 MHz)		fT	150	_		MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	2N3500, 2N3501	copo	_		8.0	pF
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)		C _{ibo}		-	80	pF
Input Impedance (I _C = 10 Mdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	2N3500 2N3501	h _{ie}	0.2 0.25		1.0 1.25	k ohms
Voltage Feedback Ratio (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	2N3500 2N3501	h _{re}		TIE.	2.5 4.0	X 10 ⁻⁴
Small-Signal Current Gain (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	2N3500 2N3501	h _{fe}	50 75	= -	300 375	-
Output Admittance (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	2N3500 2N3501	h _{oe}		=	100 200	μmhos
SWITCHING CHARACTERISTICS	and the same of th				The second second	
Delay Time (I _C = 150 mAdc, I _{B1} = 15 mAdc, V _{CC} = 100 Vdc, V _{BE} (off) = -2.0 Vdc)		t _d	510 Jan 194	20	-	ns
Rise Time (I _C = 150 mAdc, I _{B1} = 15 mAdc, V _{CC} = 100 Vdc, V _{BE} (off) = -2.0 Vdc)		t _r		35		ns
Storage Time (I _C = 150 mAdc, I _{B1} = I _{B2} = 15 mAdc, V _{CC} = 100 Vdc)		t _S	-	800	_	ns
Fall Time (I _C = 150 mAdc, I _{B1} = I _{B2} = 15 mAdc, V _{CC} = 10	00 Vdc)	tf		80		ns

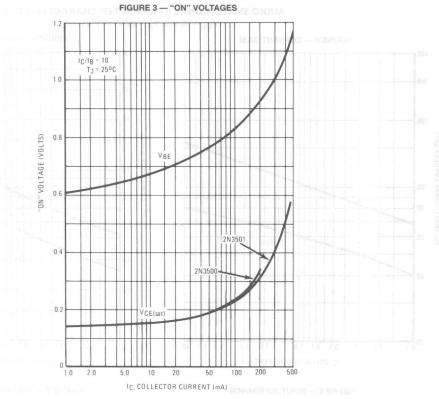
(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (2) f_T = lhfel • f_{test}.

FIGURE 1 — CURRENT GAIN CHARACTERISTICS versus JUNCTION TEMPERATURE 2N3500

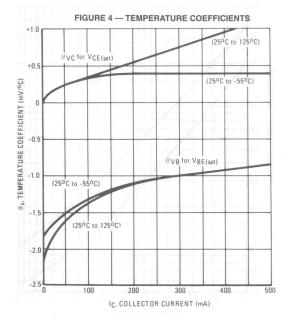








0.1 0.2



100 50 30 20 C, CAPACITANCE (pF) 10 5.0 3.0 2N3500, 2N3501 2.0 1.0

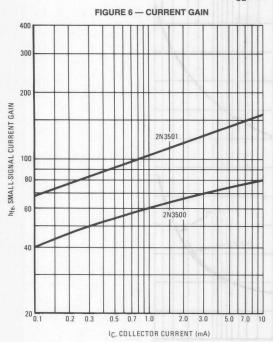
1.0 2.0

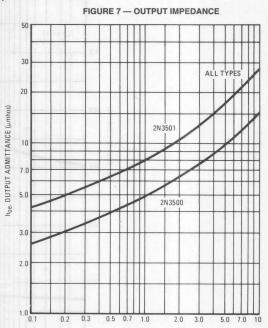
REVERSE BIAS VOLTAGE (VOLTS)

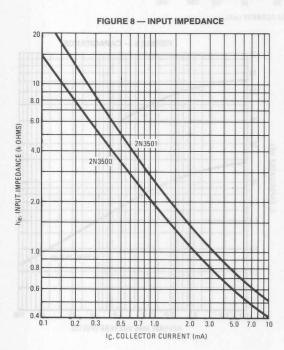
FIGURE 5 — CAPACITANCE

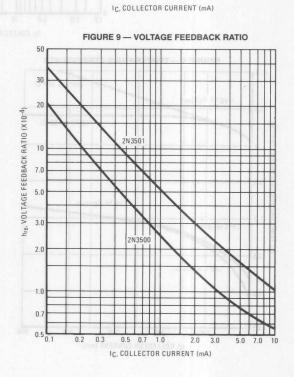
AUDIO SMALL-SIGNAL h PARAMETER CHARACTERISTICS

(V_{CE} = 10 Vdc, T_A = 25°C, f = 1.0 kHz)









Characteristic	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-12	Vdc
Collector-Base Voltage	V _{CBO}	-15	Vdc
Emitter-Base Voltage	V _{EBO}	-4.5	Vdc
DC Collector Current	nol Ic	-200	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD PD	0.36 2.06	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.2 6.9	Watts mW/°C
Operating and Storage Temperature Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.49	°C/W
Thermal Resistance, Junction to Case	$R_{\theta,IC}$	0.15	°C/W

2N3546

CASE 22-03, STYLE 1 TO-18 (TO-206AA)





SWITCHING TRANSISTOR

PNP SILICON

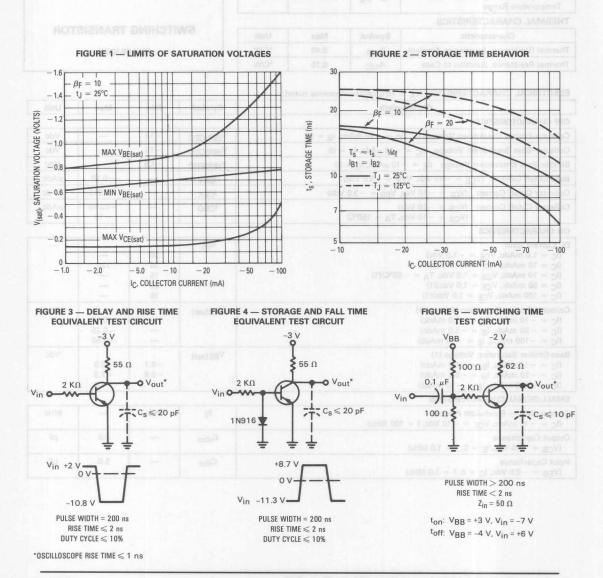
ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

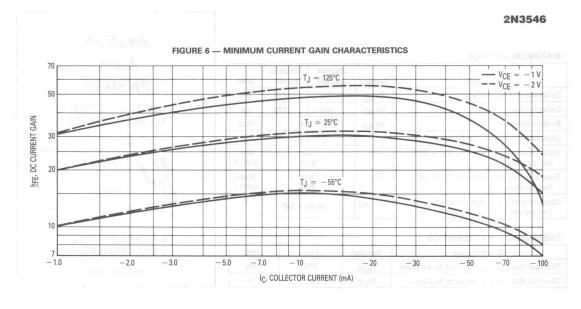
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				11-
Collector-Emitter Breakdown Voltage(1) (I _C = -10 mAdc, I _B = 0)	V(BR)CEO	-12		Vdc
Collector-Base Breakdown Voltage ($I_C = -10 \mu Adc$, $I_E = 0$)	V(BR)CBO	- 15	say Al in	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc$, $I_C = 0$)	V(BR)EBO	-4.5		Vdc
Base Cutoff Current (V _{CE} = -10 Vdc, V _{EB} = -3.0 Vdc)	IBEV	The second second	-0.10	μAdc
Collector Cutoff Current (V _{CE} = -10 Vdc, V _{EB} = -3.0 Vdc)	ICEX	to the state of th	-0.010	μAdc
Collector Cutoff Current $(V_{CB} = -10 \text{ Vdc})$ $(V_{CB} = -10 \text{ Vdc}, T_A = 150^{\circ}\text{C})$	ІСВО		-0.010 -10	μAdc
ON CHARACTERISTICS				
DC Current Gain	DS (ACI) TIPSIAU	20 30 15 25 15	120 — — —	0 0.r-
Collector-Emitter Saturation Voltage (1) $ (I_C = -10 \text{ mAdc}, I_B = -1.0 \text{ mAdc}) $ $ (I_C = -50 \text{ mAdc}, I_B = -5.0 \text{ mAdc}) $ $ (I_C = -100 \text{ mAdc}, I_B = -10 \text{ mAdc}) $	VCE(sat)	SMC TRIES	-0.15 -0.25 -0.50	Vdc
Base-Emitter Saturation Voltage (1) $ \begin{aligned} &(I_C = -10 \text{ mAdc}, I_B = -1.0 \text{ mAdc}) \\ &(I_C = -50 \text{ mAdc}, I_B = -5.0 \text{ mAdc}) \\ &(I_C = -100 \text{ mAdc}, I_B = -10 \text{ mAdc}) \end{aligned} $	VBE(sat)	-0.7 -0.8	- 0.9 - 1.3 - 1.6	Vdc
SMALL-SIGNAL CHARACTERISTICS	Contract of the Contract of th			AN TO THE REAL PROPERTY.
Current-Gain — Bandwidth Product (IC = -10 mAdc, VCE = -10 Vdc, f = 100 MHz)	fT	700	5 -	MHz
Output Capacitance (V _{CB} = -10 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	_	6.0	pF
Input Capacitance (VEB = -0.5 Vdc, I _C = 0, f = 1.0 MHz)	C _{ibo}	-	5.0	pF

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

	Symbol	Min	Max	Unit		
SWITCHING CHARA			A RATINGS	NUMIXA		
Delay Time	$I_C = -50 \text{ mA}, I_{B1} = -5.0 \text{ mA}$	Value	le de te	— pit	10	ns
Rise Time	V _{BE} = 2.0 V, V _{CC} = -3.0 V		pagy t _r	_	15	ns
Storage Time	$I_C = -50 \text{ mA}, I_{B1} = I_{B2} = -5$.0 mA	mov t _s	_	20	ns
Fall Time	V _{CC} = -3.0 V		nessV t _f		15	ns
Turn-On Time	Ade	m 005 -	o t _{on}		40	ns
Turn-Off Time	2 161		toff	ras -AT 6	30	ns
Total Control Charge (IC = 50 mA, IB = 5.0 mA, V_{CC} = 3.0 V)		2.08	QT		400	pC
		W S.F	09	2 Tc = 25Y	a Dissipation	stat Dayle

⁽¹⁾ Pulse Test: PW = 300 μ s, Duty Cycle \leq 2.0%.





10C = -20 m + 10 mAde) 10C = -20 m + 10 m + 20 m +			

Rating	Symbol	2N3634 2N3635	2N3636 2N3637	Unit
Collector-Emitter Voltage	VCEO	-140	- 175	Vdc
Collector-Base Voltage	VCBO	-140	- 175	Vdc
Emitter-Base Voltage	VEBO	-5.0		Vdc
Collector Current — Continuous	Ic	-1.0		Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 5.71		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	5.0 28.6		Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W

2N3634 thru 2N3637

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





GENERAL PURPOSE TRANSISTORS

PNP SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS		WHAT MA			
Collector-Emitter Breakdown Voltage(1) (I _C = -10 mAdc, I _B = 0)	2N3634, 2N3635 2N3636, 2N3637	V(BR)CEO	- 140 - 175	=	Vdc
Collector-Base Breakdown Voltage (IC = $-100 \mu Adc$, IE = 0)	2N3634, 2N3635 2N3636, 2N3637	V(BR)CBO	- 140 - 175		Vdc
Emitter-Base Breakdown Voltage $I_E = -10 \mu Adc, I_C = 0$)		V _{(BR)EBO}	-5.0		Vdc
Collector Cutoff Current (V _{CB} = -100 Vdc, I _E = 0)		ICBO	-	-100	nAdd
Emitter Cutoff Current (VEB = -3.0 Vdc, I _C = 0)	The Late of the Control of the Contr	IEBO		-50	nAdd
ON CHARACTERISTICS			W TO BE		
DC Current Gain (I _C = -0.1 mAdc, V _{CE} = -10 Vdc)	2N3634, 2N3636 2N3635, 2N3637	hFE	40 80	=	-
$(I_C = -1.0 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})$	2N3634, 2N3636 2N3635, 2N3637		45 90	=	
$(I_C = -10 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})(1)$	2N3634, 2N3636 2N3635, 2N3637		50 100		
$(I_C = -50 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})(1)$	2N3634, 2N3636 2N3635, 2N3637		50 100	150 300	
$(I_{C} = -150 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})(1)$	2N3634, 2N3636 2N3635, 2N3637		25 50		
Collector-Emitter Saturation Voltage(1) (I _C = -10 mAdc, I _B = -1.0 mAdc) (I _C = -50 mAdc, I _B = -5.0 mAdc)		V _{CE(sat)}	Ξ	-0.3 -0.5	Vdc
Base-Emitter Saturation Voltage(1) $ \begin{aligned} &\text{(I}_C = -10 \text{ mAdc, I}_B = -1.0 \text{ mAdc)} \\ &\text{(I}_C = -50 \text{ mAdc, I}_B = -5.0 \text{ mAdc)} \end{aligned} $		V _{BE} (sat)	 	-0.8 -0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($V_{CE} = -30 \text{ Vdc}$, $I_{C} = -30 \text{ mAdc}$, $f = 100 \text{ MHz}$)	2N3634, 2N3636 2N3635, 2N3637	fT	150 200		MHz

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Min	Max	Unit
Output Capacitance (V _{CB} = -20 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	-	10	pF
Input Capacitance ($V_{EB} = -1.0 \text{ Vdc}$, $I_{C} = 0$, $f = 1.0 \text{ MHz}$)	C _{ibo}		75	pF
$ \begin{array}{llllllllllllllllllllllllllllllllllll$		100 200	600 1200	ohms
Voltage Feedback Ratio ($I_C = -10 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h _{re}		3.0	X 10-4
Small-Signal Current Gain (I _C = -10 mAdc, V _{CE} = -10 Vdc, f = 1.0 kHz) 2N3634, 2N 2N3635, 2N		40 80	160 320	20
Output Admittance ($I_C = -10 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h _{oe}		200	μmhos
Noise Figure (I _C = -0.5 mAdc, V _{CE} = -10 Vdc, R _S = 1.0 k ohms, f = 1.0 kHz)		11.0	3.0	dB

Turn-On Time	$(V_{CC} = -100 \text{ Vdc}, V_{BE} = 4.0 \text{ Vdc},$	ton	_	400	ns
Turn-Off Time	$I_C = -50 \text{ mAdc}, I_{B1} = I_{B2} = -5.0 \text{ mAdc})$	toff	_	600	ns

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.



70 C, CAPACITANCE (pF) Cib $-0.1 \quad -0.2 - 0.3 - 0.5 \quad -1.0 \quad -2.0 - 3.0 - 5.0 \quad -10$ REVERSE BIAS (VOLTS)

FIGURE 2 — GAIN-BANDWIDTH PRODUCT

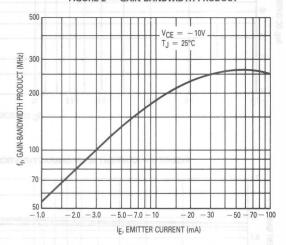
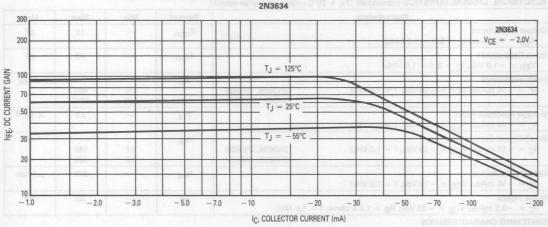


FIGURE 3 — CURRENT GAIN CHARACTERISTICS versus JUNCTION TEMPERATURE





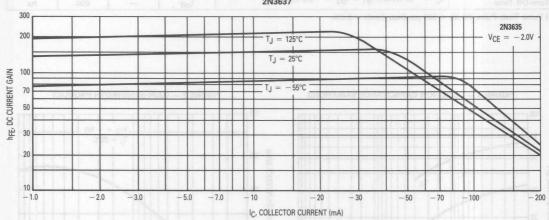
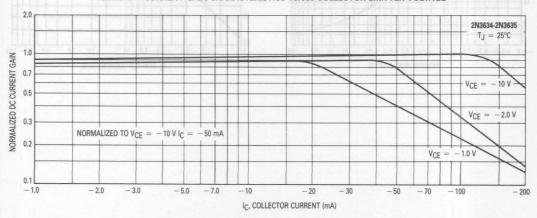
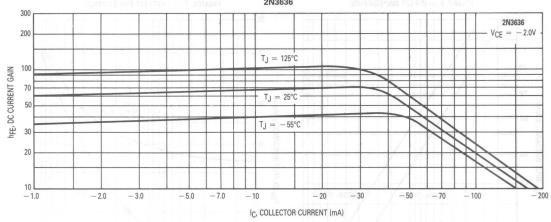


FIGURE 4 — CURRENT GAIN CHARACTERISTICS versus COLLECTOR EMITTER VOLTAGE







2N3637

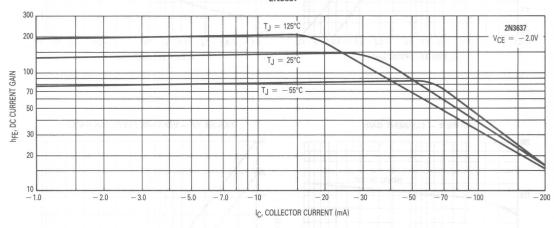
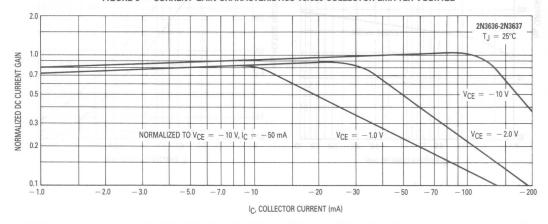
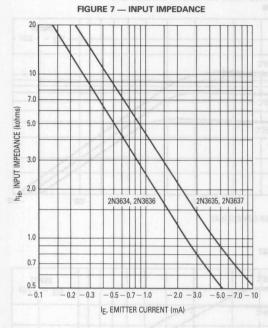
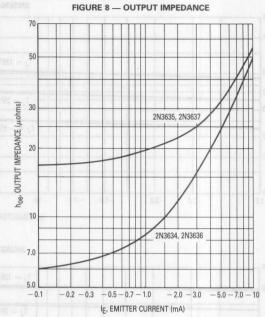
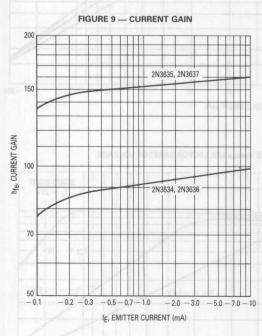


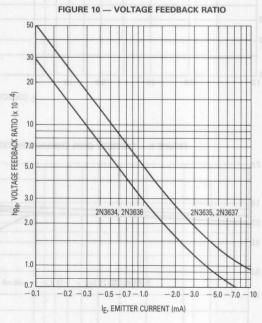
FIGURE 6 — CURRENT GAIN CHARACTERISTICS versus COLLECTOR EMITTER VOLTAGE



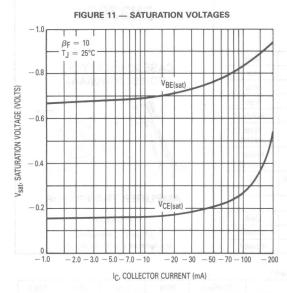








2N3634 thru 2N3637



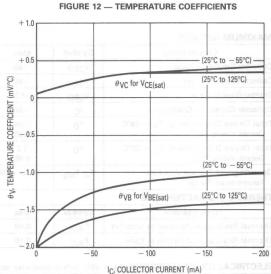
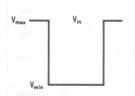


FIGURE 13 — SWITCHING TIME TEST CIRCUIT



	P.W. \cong 20 μ s DUTY CYCLE \leq 2% RISE TIME \leq 20 ns	
a dial	V _{max}	V _{min}
TURN-ON TURN-OFF	+4.0 V +4.1 V	-5.65 V -5.9 V

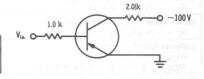
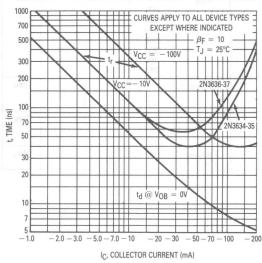
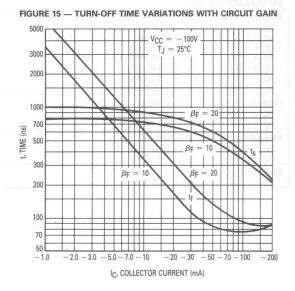


FIGURE 14 — TURN-ON TIME VARIATIONS WITH VOLTAGE





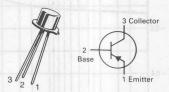
Characteristic	Symbol	Max	Unit
Collector-Emitter Voltage	VCEO	-60	Vdc
Collector-Base Voltage	VCBO	-60	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current — Continuous	Ic	-50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.36 2.06	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.2 6.86	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	R_{θ} JA	0.49	°C/mW
Thermal Resistance, Junction to Case	R_{θ} JC	0.15	°C/mW

2N3799*

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



AMPLIFIER TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit	
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I _C = -10 mAdc, I _B = 0)	эмит эминотиме	V _{(BR)CEO}	-60		-	Vdc
Collector-Base Breakdown Voltage $(I_C = -10 \mu Adc, I_E = 0)$	W. == 20 p. s	V _(BR) CBO	-60	_		Vdc
Emitter-Base Breakdown Voltage (I _E = -10μ Adc, I _C = 0)	m.61 = 3467.32	V(BR)EBO	-5.0	-	-	Vdc
Collector Cutoff Current $(V_{CB} = -50 \text{ Vdc}, I_{E} = 0)$ $(V_{CB} = -50 \text{ Vdc}, I_{E} = 0, T_{A} = 150^{\circ}\text{C})$		ICBO	=	_	-0.01 -10	μAdc
Emitter Cutoff Current $(V_{EB} = -4.0 \text{ Vdc}, I_{C} = 0)$	IEBO		-	-20	nAdd	
ON CHARACTERISTICS						
DC Current Gain $ \begin{aligned} &(I_C = -1.0 \; \mu \text{Adc, V}_{CE} = -5.0 \; \text{Vdc}) \\ &(I_C = -10 \; \mu \text{Adc, V}_{CE} = -5.0 \; \text{Vdc}) \\ &(I_C = -100 \; \mu \text{Adc, V}_{CE} = -5.0 \; \text{Vdc}) \\ &(I_C = -100 \; \mu \text{Adc, V}_{CE} = -5.0 \; \text{Vdc}) \\ &(I_C = -100 \; \mu \text{Adc, V}_{CE} = -5.0 \; \text{Vdc}) \\ &(I_C = -500 \; \mu \text{Adc, V}_{CE} = -5.0 \; \text{Vdc}) \\ &(I_C = -1.0 \; \text{mAdc, V}_{CE} = -5.0 \; \text{Vdc}) \\ &(I_C = -10 \; \text{mAdc, V}_{CE} = -5.0 \; \text{Vdc}) \end{aligned} $	0000 Barry 0000 Barry 00000 Ba	h _{FE}	75 225 300 150 300 300 250		900	000 003 0001 0001
Collector-Emitter Saturation Voltage ($I_C = -100 \mu Adc$, $I_B = -10 \mu Adc$) ($I_C = -1.0 \mu Adc$, $I_B = -100 \mu Adc$)	2003	VCE(sat)			-0.2 -0.25	Vdc
Base-Emitter Saturation Voltage (I _C = $-100~\mu$ Adc, I _B = $-10~\mu$ Adc) (I _C = $-1.0~m$ Adc, I _B = $-100~\mu$ Adc)		V _{BE(sat)}	4		-0.7 -0.8	Vdc
Base-Emitter On Voltage $(I_C = -100 \mu Adc, V_{CF} = -5.0 Vdc)$	Total Control of the	V _{BE(on)})		-0.7	Vdc

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	виТур в в	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (IC = $-500 \mu\text{Adc}$, VCE = -5.0Vdc , f = 20 MHz) (IC = -1.0mAdc , VCE = -5.0Vdc , f = 100 MHz)	fT 201.00	30 100	- 3 Z Z	500	MHz
Output Capacitance (V _{CB} = -5.0 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	E A:		4.0	pF
Input Capacitance $(V_{EB} = -0.5 \text{ Vdc, I}_{C} = 0, f = 1.0 \text{ MHz})$	C _{ibo}	7 As <u>-4</u> 31 -	* ? []	8.0	pF
Input Impedance (IC = -1.0 mAdc, VCE = -10 Vdc, f = 1.0 kHz)	hie	10		40	k ohms
Voltage Feedback Ratio ($I_C = -1.0 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h _{re}			25	X 10-4
Small-Signal Current Gain (IC = -1.0 mAdc , VCE = -10 Vdc , f = 1.0 kHz)	h _{fe}	300	3 D.T	900	
Output Admittance ($I_C = -1.0 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h _{oe}	5.0	iam ji	60	μ mhos
Noise Figure (I _C = $-100~\mu$ Adc, V _{CE} = $-10~\text{Vdc}$, R _G = 3.0 k ohms), f = $100~\text{Hz}$, B.W. = $20~\text{Hz}$	NF	_	2.5	4.0	dB
Spot f = 1.0 kHz, B.W. = 200 Hz		_	0.8	1.5	
Noise f = 10 kHz, B.W. = 2.0 kHz		_	0.8	1.5	
f = 1.0 kHz			1.5	2.5	

SPOT NOISE FIGURE

 $(V_{CE} = 10 \text{ Vdc}, T_A = 25^{\circ}\text{C})$

FIGURE 1 — SOURCE RESISTANCE EFFECTS, f = 1.0 kHz

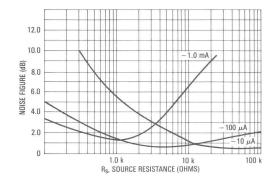
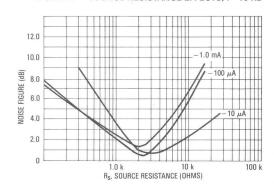
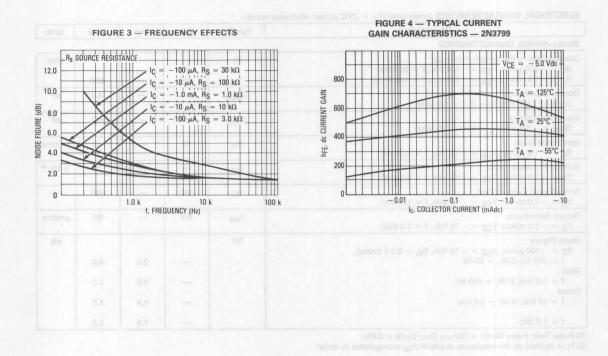


FIGURE 2 — SOURCE RESISTANCE EFFECTS, f = 10 Hz



⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0% (2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.



Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	VCBO	60	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	IC	200	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	e) PD	0.36 2.06	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	and PD	1.2 6.9	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	R_{θ} JC	0.15	°C/mW
Thermal Resistance, Junction to Ambient	$R_{\theta}JA$	0.49	°C/mW

2N3947*

CASE 22-03, STYLE 1 TO-18 (TO-206AA)





GENERAL PURPOSE TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc)		V(BR)CEO	40	_	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu Adc$, $I_E = 0$)		V(BR)CBO	60	_	Vdc
Emitter-Base Breakdown Voltage (IE = 10 µAdc, I _C = 0)		V(BR)EBO	6.0	_	Vdc
Collector Cutoff Current (VCE = 40 Vdc, VEB = 3.0 Vdc) (VCE = 40 Vdc, VEB = 3.0 Vdc, TA = 150°C)	DAGAMA EURATINA	ICEX	=	0.010 15	μAdc
Base Cutoff Current (V _{CE} = 40 Vdc, V _{EB} = 3.0 Vdc)	25°C unless otherwise	= AT) IBL	_	.025	μAdc
ON CHARACTERISTICS			MA PRO		
DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc)(1)	000	h _{FE}	60 90 100 40	300	Jose Jose Jose Jose Jose Jose Jose Jose
Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc)	Dit 8	VCE(sat)		0.2 0.3	Vdc
Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc)	02	V _{BE(sat)}	0.6	0.9	Z
SMALL-SIGNAL CHARACTERISTICS	00			14-	35
Current Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz)	05	fT	300		MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	101	C _{obo}		4.0	pF

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

		Symbol	Min	Max	Unit
rinu	Valua	Cibo	-	8.0	pF
Vdc	08	h _{ie}	2.0	12	kohms
Vdc	8.0	ole h _{re}	strour	20	X 10-4
staW D^\VVrn	0.36	g h _{fe}	100	700	l ecive C let vods otateC
Watte Watte	1.2	n _{oe}	5.0	50	μmhos
-D*	-66 to +200	rb'C _C	mollan	200	ps
Noise Figure (I _C = 100 μ A, V _{CE} = 5.0 V, R _g = 1.0 k Ω , f = 1.0 kHz)			SOLUSIE	5.0	dB
tinit .	Miles	ledmy3	ol	Characterial	
	D kHz)	26V 28 26	Cibo hie hre hfe hoe rb'Cc NF	Cibo — hie 2.0 hre — hfe 100 hoe 5.0 rb'C _c — NF —	Cibo — 8.0 hie 2.0 12 hre — 20 hfe 100 700 hoe 5.0 50 rb'C _C — 200 NF — 5.0

Delay Time	V _{CC} = 3.0 Vdc, V _{BE} = -0.5 Vdc	ought _d	oon t⇔Case	35	ns
Rise Time	I _C = 10 mAdc, I _{B1} = 1.0 mA	ALSE tr	naidm/—t noit	35	ns ns
Storage Time	$V_{CC} = 3.0 \text{ V, } I_{C} = 10 \text{ mA,}$	t _S	_	375	ns
Fall Time	$I_{B1} = I_{B2} = 1.0 \text{ mAdc}$	o ass nu O'tf	eni st ics it	75	ns

(1) Pulse Test: PW \leq 300 μ s, Duty Cycle \leq 2%

TYPICAL SWITCHING CHARACTERISTICS (T_A = 25°C unless otherwise noted)

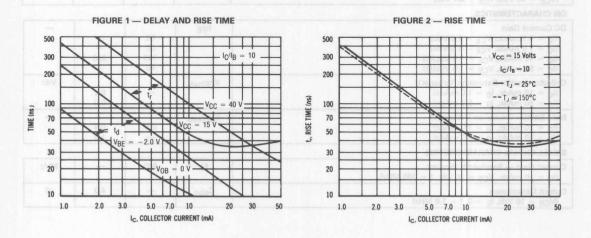


FIGURE 3 — STORAGE AND FALL TIMES

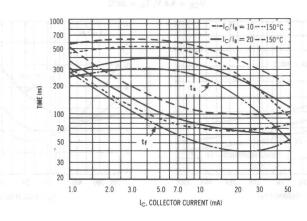
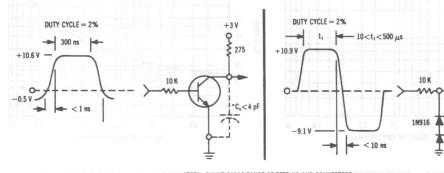


FIGURE 4 — TURN-ON TIME EQUIVALENT TEST CIRCUIT

FIGURE 5 — TURN-OFF TIME EQUIVALENT TEST CIRCUIT

+3 V

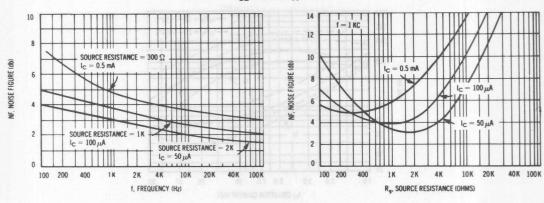
Q ≱ 275



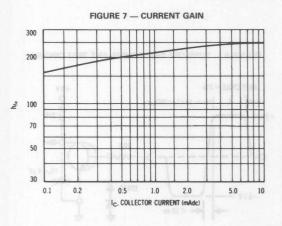
*TOTAL SHUNT CAPACITANCE OF TEST JIG AND CONNECTORS

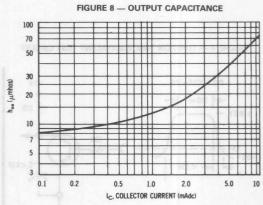
AUDIO SMALL-SIGNAL CHARACTERISTICS

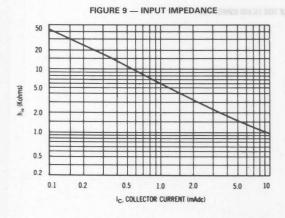
FIGURE 6 — NOISE FIGURE VARIATIONS $V_{CE} = 5.0 \text{ V}, T_A = 25^{\circ}\text{C}$



h PARAMETERS V_{CE} = 10 V, T_A = 25°C, f = 1.0 kc







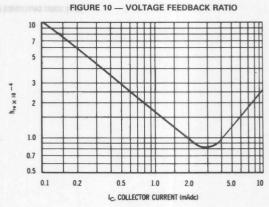


FIGURE 11 — CURRENT GAIN CHARACTERISTICS

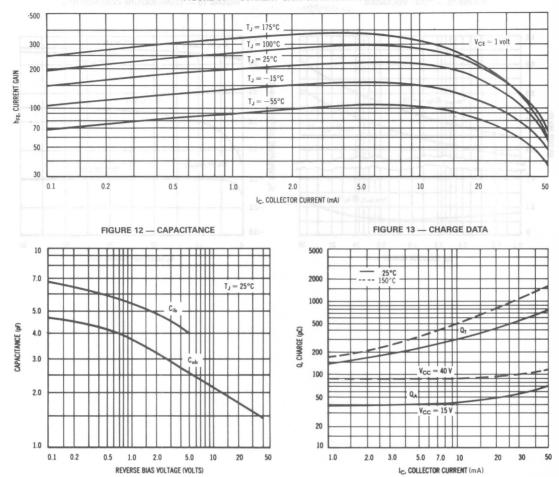


FIGURE 14 — COLLECTOR SATURATION REGION

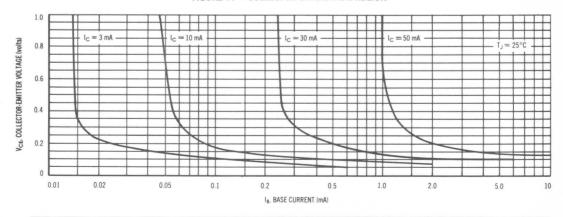
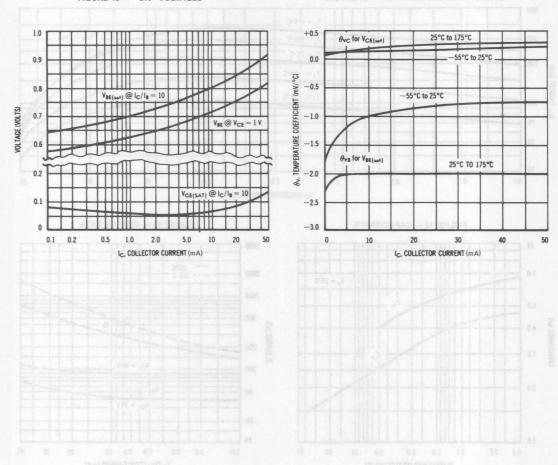




FIGURE 16 — TEMPERATURE COEFFICIENTS



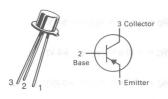
Rating	Symbol	2N3964	2N3963	Unit		
Collector-Emitter Voltage	VCEO	-45	-80	V		
Collector-Base Voltage	V _{CBO}	-45	-80	٧		
Emitter-Base Voltage	V _{EBO}	_	6.0	V		
Collector Current — Continuous	Ic	-200		mA		
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.36 2.06		0.00		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.2 6.85		Watts mW/°C		
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200		°C		

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	486	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	146	°C/W

2N3963, 2N3964*

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



AMPLIFIER TRANSISTORS

PNP SILICON

★This is a Motorola designated preferred device.

Refer to 2N3799 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Charac	teristic			Symbol	Min	Max	Unit
OFF CHARACTERISTICS	5 Irl					198	pur Impeda
Collector-Emitter Breakdown Voltage (IC = -5.0 mA)		2N3963 2N3964	490\$A/7	V(BR)CEO	-80 -45	= 30V Vet	Vdc
Collector-Emitter Breakdown Voltage ($I_C = -10 \mu A$)	od	2N3963 2N3964	ri Lintès	V _(BR) CES	-80 -45	- 30Y - 10 (1 - 20 Cain - 30#	Vdc
Collector-Base Breakdown Voltage (IC = -10μ A)	1971	2N3963 2N3964	ARUCHS toliting-in EDECHS	V(BR)CBO	-80 -45	0 0 br—	Vdc a shurings 0 = 50
Emitter-Base Breakdown Voltage ($I_E = -10 \mu A$	ROST		PERSONAL PROPERTY.	V(BR)EBO	-6.0	0.467	Vdc
Collector Cutoff Current (V _{CE} = -40 V) (V _{CE} = -70 V)	05	2N3964 2N3963	ASOCKS	ІСВО	-5.0.2	-10 -10	nAdc
Collector Cutoff Current (VCE = -70 V) (VCE = -40 V)		2N3963 2N3964	0 - 0 (18 ma)	ICES	VIO V II.E	-10 -10	nAdc
Emitter Cutoff Current (VEB = -4.0 V)			Makey	IEBO	_	-10	nAdc
ON CHARACTERISTICS			Electricia.	. H 081 =	WH V 6.3	= 35V Au	(1c = -20)
DC Current Gain (I _C = -10μ A, V _{CE} = -5.0 V)		2N3963 2N3964	243883 243684	hFE .sel et :	100 250	300 500	6c = - 20 1 = 160 Ha
$(I_C = -100 \ \mu A, V_{CE} = -5.0 \ V)$		2N3963 2N3964	P643.412	sH 0.5 =	100 250	= <u>10</u> V Au (6) TO (6)V	(Ic = 25 t = 10 Hz.
$(I_C = -1.0 \text{ mA}, V_{CE} = -5.0)$		2N3963 2N3964	10	ity Cycle = 2 g	100 250	450 600	Pulse Tast.
$(I_C = -10 \mu A, V_{CE} = -5.0, T_A = -55$	5°C)	2N3963 2N3964			40 100	_	

(continued)

		State All Control of the Control of		
ELECTRICAL (CHARACTERISTICS	(continued) /Ta	- 25°C unless	otherwise noted)

Characteristic	21052	December 1	Symbol	Min	Max	Unit
DC Current Gain continued	W.	08 - 36 -	Veeo		apsileV jet	actor-Em
$(I_C = -1.0 \text{ mA}, V_{CE} = -5.0 \text{ V}, T_A = 100^{\circ}\text{C}))$	2N3963		080	_	600	ea8-10306
	2N3964			_	800	see S very
			QBBV.		1/0/4/10/3	102810-1011
$(I_C = -1.0 \mu\text{A}, V_{CE} = -5.0 \text{V})$	2N3963		al le	60	macO—-me	ector Cini
	2N3964		d9 - 1	180	reodstream	leolivad la
					0	TA = 28
$(I_C = -10 \mu A, V_{CE} = -5.0 V)$	2N3963			100	e 25 C	one etem
	2N3964		40	200	notiseissk	
(1 50 4 1/ 50)(1)	0.00000		99	90		TC = 28
$(I_C = -50 \text{ mA}, V_{CE} = -5.0)(1)$	2N3963 2N3964			180	2185 e	
	2113904		1 1 1	100		
$(I_C = -50 \text{ mA}, V_{CE} = -5.0, T_A = -55^{\circ}C)(1)$	2N3963		gts Tut Tatg	45	nt aginoss i	one entire
(IC30 IIIA, VCE3.0, IA33 C/(1)	2N3964			90	all other	utstagma
	2110004					-
Collector-Emitter Saturation Voltage			VCE(sat)		ATO A OF	V
$(I_C = -10 \text{ mA}, I_B = -0.5 \text{ mA})(1)$			Index 10		-0.25	
$(I_C = -50 \text{ mA}, I_B = -5.0 \text{ mA})(1)$			- Constitution		-0.4	V
Base-Emitter Saturation Voltage			VBE(sat)		tance, Juria	mai Resi
$(I_C = -10 \text{ mA}, I_B = -0.5 \text{ mA})(1)$			DEBUT	on to Case	0.9	V
$(I_C = -50 \text{ mA}, I_B = -5.0 \text{ mA})(1)$				_	0.95	V
SMALL-SIGNAL CHARACTERISTICS		426 5				
Ouput Capacitance			Cobo		6.0	pF
$(V_{CB} = -5.0 \text{ V, f} = 1.0 \text{ MHz})$			-000			
		Charon selviertra ce	C. = A	BONTERE	15	pF
Input Capacitance			Cibo	10	15	pr
$(V_{EB} = -0.5 \text{ V, f} = 1.0 \text{ MHz})$			Olishanas	1410		
Input Impedance			h _{ie}		SOLLSHEL	kΩ
$(I_C = -1.0 \text{ mA}, V_{CE} = -5.0 \text{ V}, f = 1.0 \text{ kHz})$	2N3963			2.5	17	mil-rotes
OB. Salami	2N3964	CHICAGO		6.0	20	10
Voltage Feedback Ratio			hre		10	10-4
$(I_C = -1.0 \text{ mA}, V_{CE} = -5.0, f = 1.0 \text{ kHz})$					alika entika e	and anima
Small Signal Current Gain		5865143	h _{fe}		(A)	01- = 1
$(I_C = -1.0 \text{ mA}, V_{CE} = -5.0 \text{ V}, f = 1.0 \text{ kHz})$	2N3963		16	100	550	_
02	2N3964			250	700	-
Magnitude of Forward Current Transfer Ratio, Com	mon-Emitter	1325143	hfe			DT- = 0
$(I_C = -0.5 \text{ mA}, V_{CE} = -5.0 \text{ V}, f = 20 \text{ MHz})$	2N3963		l'itel	2.0	8.0	
11C 0.0 117 4 CE 0.0 47 1 20 111 127	2N3964			2.5	8.0	
Output Admittance			-	-10	The state of the state of	Date Sand
Output Admittance	2N3963		hoe	5.0	40	μmho
$(I_C = -1.0 \text{ mA}, V_{CE} = -5.0, f = 1.0 \text{ kHz})$	2N3963 2N3964			5.0	50	anu3 rates
01	2143304	3,302,41		5.0		- 30
Noise Figure	ONIOCCO		NF		IV 0	dB
$(I_C = -20 \text{ mA}, V_{CE} = -5.0 \text{ V}, BW = 15.7 \text{ kHz})$	2N3963				3	setor Culo
	2N3964				2	(= 30
$(I_C = -20 \mu A, V_{CE} = -5.0 \text{ V}, BW = 1.5 \text{ kHz},$	2N3963				3	30
$f = 10 \text{ kHz}, R_S = 10 \text{ k}\Omega$	2N3963 2N3964				2	tter Cutoff
10 1112, 115 - 10 1221	2140304				a vo	
$(I_C = -20 \mu A, V_{CE} = -5.0 \text{ V}, BW = 150 \text{ Hz},$	2N3963			_	3	
$f = 1.0 \text{ kHz}, R_S = 10 \text{ k}\Omega$	2N3964				2	
330					ni	Surrant Ge
$(I_C = -20 \mu A, V_{CE} = -5.0 \text{ V}, BW = 15 \text{ Hz},$	2N3963			W 9.5	10	31- = 5
$f = 100 \text{ Hz}, R_S = 10 \text{ h}\Omega)$	2N3964				4	
$(I_C = -20 \mu A, V_{CE} = -5.0 \text{ V}, BW = 2.0 \text{ Hz},$	2N3964			1V.0.2-	8	101 1
$f = 10 \text{ Hz}, R_S = 10 \text{ k}\Omega$						

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

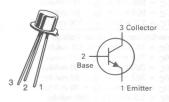
Rating	Symbol	2N4014	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	V _{CBO}	80	Vdc
Emitter-Base Voltage	V _{EBO}	6.0	Vdc
Collector Current — Continuous — Peak	IC	1.0 2.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.5 2.86	Watts mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.4 8.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	350	°C/W
Thermal Resistance, Junction to Case	R_{θ} JC	125	°C/W

2N4014

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



SWITCHING TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	(SigAm 0	d - pal als	im 002 = 91		ise Tame
Collector-Emitter Breakdown Voltage (1) (I _C = 10 mAdc, I _B = 0)	V(BR)CEO	40	IVOC = JOVI		Vdc
Collector-Emitter Breakdown Voltage (I _C = 10 µAdc, V _{BE} = 0)	V(BR)CES	80	I B admirgistr	_	Vdc
Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0)	V(BR)CBO	80	in Old — gl	_	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0)	V(BR)EBO	6.0	05 = 30 V	_	Vdc
Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 60 Vdc, I _E = 0, T_A = 100°C)	ICBO_	Dury C vola	0.12	1.7 120	μAdc
Collector Cutoff Current (VCE = 80 Vdc, V _{EB} = 0)	ICES	_	0.15	10	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain ($I_C = 10 \text{ MAdc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 100 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 100 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$, $I_C = 100 \text{ mAdc}$, $I_C = 1.0 \text{ Vdc}$) ($I_C = 300 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 500 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 500 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 500 \text{ mAdc}, V_{CE} = 2.0 \text{ Vdc}$) ($I_C = 800 \text{ mAdc}, V_{CE} = 2.0 \text{ Vdc}$)	hFE h	30 60 30 40 35 20 20	-	 150 	_
$(I_C = 1.0 \text{ Adc}, V_{CE} = 5.0 \text{ Vdc})$	Here is the same of	25	_	_	

(continued)

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
Collector-Emitter Saturation Voltage	tiett	VCE(sat)	limos T			Vdc
$(I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc})$			_	0.17	0.25	-
(I _C = 100 mAdc, I _B = 10 mAdc)		194	334 —	0.19	0.26	liant-notes!
(I _C = 300 mAdc, I _B = 30 mAdc)		08	enV -	0.25	0.40	lactor-Buse
(I _C = 500 mAdc, I _B = 50 mAdc)			_	0.30	0.52	
(I _C = 800 mAdc, I _B = 80 mAdc)		0.0	1884	0.43	0.80	\$600 D 1000
(I _C = 1.0 mAdc, I _B = 100 mAdc)		0.6	0 -	0.55	0.95	ingular Curr
Base-Emitter Saturation Voltage		V _{BE(sat)}			REST	Vdc
(Ic = 10 mAdc, Ig = 1.0 mAdc)		0.0	PD -	O TA- 25TD	0.76	al Dayles I
(I _C = 100 mAdc, I _B = 10 mAdc)		2.6	_	_	0.86	repuis suppre
$(I_C = 300 \text{ mAdc}, I_B = 30 \text{ mAdc})$			-	100 To Y 10	1.1	and Phonoise
(I _C = 500 mAdc, I _B = 50 mAdc)			0.8	5 177 - 21 3	1.1	- de otros
(I _C = 800 mAdc, I _B = 80 mAdc)					1.5	A11 4 1914 101
(I _C = 1.0 Adc, I _B = 100 mAdc)		CC 4 IN 38 - 10	1 11	<u>normanu</u>	1.7	eratitrig sere

O O B. J.		200	BURTON	DIDARAM	NAU I
Current-Gain — Bandwidth Product(2) (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	T I	300	98	Cheructeria	MHz
Output Capacitance	Cobo	ent - Pari	dmA = nois	10	pF
(V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	128	Tan Bush	tion to Case	net annure	email Res
Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	C _{ibo}	-	-	55	pF

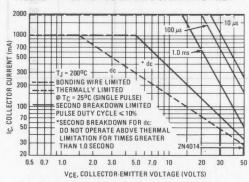
SWITCHING CHARACTERISTICS

Delay Time	$(V_{CC} = 30 \text{ Vdc}, V_{BE(off)} = 3.8 \text{ Vdc},$	td	sits!	5.0	10	ns
Rise Time	I _C = 500 mAdc, I _{B1} = 50 mAdc) (Figures 8,10)	t _r	-	15	30	RF CHARAC
Storage Time	(V _{CC} = 30 Vdc, I _C = 500 mAdc,	t _S	4-1	30	50	ns
Fall Time	I _{B1} = I _{B2} = 50 mAdc) (Figures 9,10)	tf		20	25	ns
Turn-On Time	$(V_{CC} = 30 \text{ Vdc}, V_{BE(off)} = 3.8 \text{ Vdc}, \\ I_{C} = 500 \text{ mAdc}, I_{B1} = 50 \text{ mAdc}) \\ (Figures 8, 10)$	ton	_	20	35	ns ns ns ns ns ns ns ns ns ns ns ns ns n
Turn-Off Time	(V _{CC} = 30 Vdc, I _C = 500 mAdc, I _{B1} = I _{B2} = 50 mAdc) (Figures 9, 10)	toff	_	50	60	ns

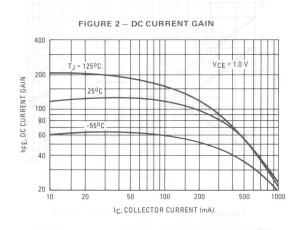
(1) Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 1.0%.

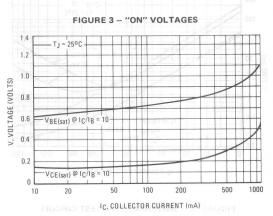
(2) $f_T = |hfe| \cdot f_{test}$.

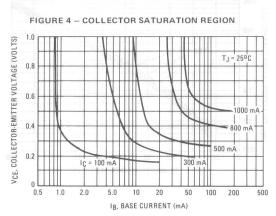
FIGURE 1 - ACTIVE-REGION SAFE OPERATING AREA

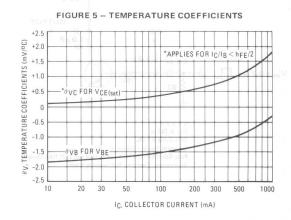


TYPICAL DC CHARACTERISTICS

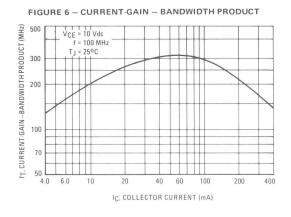


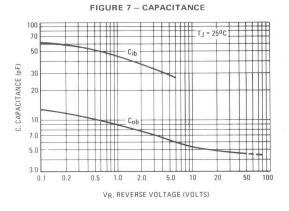






TYPICAL DYNAMIC CHARACTERISTICS





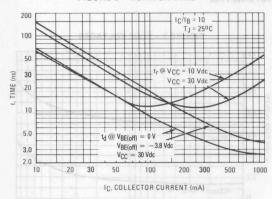


FIGURE 8 - TURN-ON TIME 2017219 10 AND 30 LAGHEY FIGURE 9 - TURN-OFF TIME

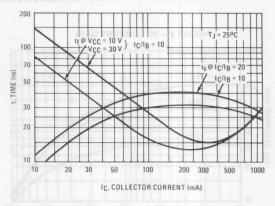


FIGURE 10 - SWITCHING TIME TEST CIRCUIT

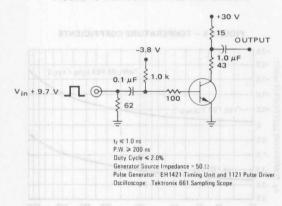
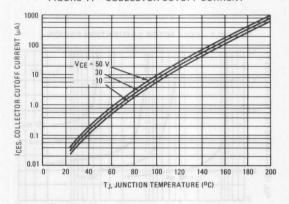


FIGURE 11 - COLLECTOR CUTOFF CURRENT



Rating	Symbol	2N4032	2N4033	Unit
Collector-Emitter Voltage	VCEO	-60	-80	Vdc
Collector-Base Voltage	V _{CBO}	-60	-80	Vdc
Emitter-Base Voltage	VEBO	-5.0	-5.0	Vdc
Os:	YBE	2N4032	2N4033	
Collector Current — Continuous	Ic	_	1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.8 4.56		W mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD		.0 2.8	W mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to	+200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	140	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

2N4032 2N4033

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N4405 for graphs.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS		(=3)7-0	70	The syn ode	377
Collector-Emitter Breakdown Voltage(1) (I _C = -10 mA)	2N4032 2N4033	V(BR)CEO	-60 -80	_	V
Collector-Base Breakdown Voltage (IC = -10μ A)	2N4032 2N4033	V(BR)CBO	-60 -80	_	V
Emitter-Base Breakdown Voltage ($I_E = -10 \mu A$)		V(BR)EBO	-5.0	_	V
Collector Cutoff Current $(V_{CB} = -50 \text{ V})$ $(V_{CB} = -60 \text{ V})$ $(V_{CB} = -60 \text{ V}, T_{A} = 150^{\circ}\text{C})$ $(V_{CB} = -60 \text{ V}, T_{A} = 150^{\circ}\text{C})$	2N4032 2N4033 2N4032 2N4033	ІСВО		-50 -50 -50 -50	nA μA
Emitter Cutoff Current (V _{EB} = -5.0 V)		I _{EBO}	_	-10	μΑ
ON CHARACTERISTICS					
DC Current Gain (I _C = -100 mA, V _{CE} = -5.0 V, @ -55° C)(1)	2N4032,33	hFE	40	_	-
$(I_C = -100 \ \mu A, V_{CE} = -5.0 \ V)$	2N4032,33		75	_	
$(I_C = -100 \text{ mA}, V_{CE} = -5.0 \text{ V})(1)$	2N4032,33		100	300	
$(I_C = -500 \text{ mA}, V_{CE} = -5.0 \text{ V})(1)$	2N4032,33		70	_	
$(I_C = -1.0 \text{ A, V}_{CE} = -5.0 \text{ V})F(1)$	2N4032 2N4033		40 25	_	

ELECTRICAL CHARACTERISTICS	(continued) (TA =	25°C unless otherwise noted.)
-----------------------------------	-------------------	-------------------------------

Characteristic				Symbol	Min	Max	Unit
Collector-Emitter Saturation Voltage(1) (I _C = -150 mA, I _B = -15 mA)	seV	08-	00-	VCE(sat)		-0.15	V
$(I_C = -500 \text{ mA}, I_B = -50 \text{ mA})$ $(I_C = -1.0 \text{ A}, I_B = -100 \text{ mA})$	2N4032			VERG	Ξ	-0.50 -1.0	
Base-Emitter Saturation Voltage(1) (I _C = -150 mA, I _B = -15 mA)	-bA	204093	28/4032	V _{BE(sat)}	- nationality	-0.9	٧
Base-Emitter On Voltage $(I_C = -1.0 \text{ A}, V_{CE} = -1.0 \text{ V})$ $(I_C = -500 \text{ mA}, V_{CE} = -0.5 \text{ V})(1)$	2N4032		4.6	V _{BE} (on)	Ø T <u>A</u> = 28	-1.2 -1.1	Derate a
SMALL-SIGNAL CHARACTERISTICS	Para Maria		1.0	64	97 = 21 m	halfaçiselü ed	IVOU 1610
Ouput Capacitance (V _{CE} = -10 V, f = 1.0 MHz)	99	+200	ot 68 -	C _{obo}	nallanul	20	pF
Input Capacitance (V _{EB} = -0.5 V, f = 1.0 MHz)				C _{ibo}	_	110	pF
Small Signal Current Gain (I _C = -50 mA, V _{CE} = -10 V, f = 100 MHz)				h _{fe}	1.5	5.0	- Train Train
SWITCHING CHARACTERISTICS	W/O°		0140	ALaR Ineld	etion to Am	esistance, Jun	A lerman
Storage Time $(I_C = -500 \text{ mA}, I_{B1} = I_{B2} = -50 \text{ mA})$	WYDe		25	t _s	ction <u>r</u> o Cae	350	ns
Turn-On Time (I _C = -500 mA, I _{B1} = -50 mA)		(Joeton	salwierlio agr	ton	EDITERRETICS	100	ns
Fall Time $(I_C = -500 \text{ mA}, I_{B1} = I_{B2} = -50 \text{ mA})$				tf man	o -	50	ns
1) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.			2N4032 2N4033	(1)	own Voltage	mitter Broakd 10 mA)	3-rotoello - = gi)

Rating	Symbol	2N4036	2N4037	Unit
Collector-Emitter Voltage	VCEO	-65	-40	Vdc
Collector-Base Voltage	VCBO	-90	-60	Vdc
Emitter-Base Voltage	VEBO	-7.0	-7.0	Vdc
Base Current	IB	-	-0.5	
Collector Current — Continuous	Ic	-1.0		Adc
Continuous Power Dissipation at or Below T _C = 25°C Linear Derating Factor	PD	5.0 28.6	5.0 28.6	Watts mW/°C
Continuous Power Dissipation at or Below T _A = 25°C Linear Derating Factor	PD	1.0 5.72	1.0 5.72	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200		°C
Lead Temperature 1/16" from Case for 10 Seconds	TL	230		°C

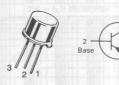
THERMAL CHARACTERISTICS

Characteristic	Symbol	2N4036	2N4037	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	35	°C/W

2N4036 2N4037

CASE 79-04, STYLE 1 TO-39 (TO-205AD)

3 Collector



GENERAL PURPOSE TRANSISTORS

PNP SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS		JEAS-OT-ROTODUS	0		
Collector-Emitter Sustaining Voltage (I _C = -100 mAdc, I _B = 0)(1)	2N4036 2N4037	VCEO(sus)	-65 -40	I	Vdc
Collector-Base Breakdown Voltage (I _C = −0.1 mAdc)	2N4037	V(BR)CBO	-60	-	Vdc
Collector Cutoff Current (V _{CE} = -85 V, V _{EB} = -1.5 V) (V _{CE} = -30 V, V _{EB} = -1.5 V, T _C = 150°C)	2N4036 2N4037	ICEX	No.	-0.1 -100	mAdc
Collector Cutoff Current $(V_{CB} = -90 \text{ V}, _{E} = 0)$ $(V_{CB} = -60 \text{ V}, _{E} = 0)$	2N4036 2N4037	ICBO	-3	-1.0 -0.25	μAdc
Emitter Cutoff Current $(V_{EB} = -7.0 \text{ Vdc}, I_C = 0)$ $(V_{EB} = -5.0 \text{ Vdc}, I_C = 0)$	2N4036 2N4037	I _{EBO}		-10 -1.0	μAdc
ON CHARACTERISTICS					Though A.
DC Current Gain ($I_C = -0.1 \text{ mAdc}$, $V_{CE} = -10 \text{ V}$) ($I_C = -1.0 \text{ mAdc}$, $V_{CE} = -10 \text{ V}$)	2N4036 2N4037	hFE	20 15	1 = 18	10-1
$(I_C = -150 \text{ mAdc}, V_{CE} = -10 \text{ V})(1)$	2N4036 2N4037		40 50	140 250	
$(I_C = -150 \text{ mAdc}, V_{CE} = -2.0 \text{ V})(1)$	2N4036	an essentia con	20	200	
$(I_C = -500 \text{ mAdc}, V_{CE} = -10 \text{ V})(1)$	2N4036	8001	20	3 -	
Collector-Emitter Saturation Voltage $(I_C = -150 \text{ mA}, I_B = -15 \text{ mA})(1)$	2N4036 2N4037	VCE(sat)	SOMEON AS	-0.65 -1.4	V
Base-Emitter Saturation Voltage ($I_C = -150 \text{ mA}$, $I_B = -15 \text{ mA}$)(1)	2N4036	V _{BE(sat)}	_	-1.4	V
Base-Emitter On Voltage ($I_C = -150$ mA, $V_{CE} = -10$ V)(1)	2N4037	V _{BE(on)}	res (t _{el} t) eri	-1.5	V
SMALL-SIGNAL CHARACTERISTICS					1
Collector-Base Capacitance (V _{CB} = -10 V, f = 1.0 MHz)	2N4037	C _{cb}		30	pF
Current Gain — High Frequency (I _C = -50 mA, V _{CE} = -10 V, f = 20 MHz)	2N4036 2N4037	h _{fe}	3.0 3.0	_ 10	- 0.5
SWITCHING CHARACTERISTICS					0.4.0
Rise Time $(I_{B1} = -15 \text{ mA})$	2N4036	t _r		70	ns
Storage Time (I _{B2} = -15 mA)	2N4036	t _S		600	ns
Fall Time ($I_{B2} = -15 \text{ mA}$)	2N4036	tf		100	ns
Turn-On Time (I _{B1} = I _{B2})	2N4036	ton	ATTEMENT AT	110	ns
Turn-Off Time –(I _{B1} = I _{B2})	2N4036	toff	-	700	ns

(1) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

FIGURE 1 — CURRENT GAIN CHARACTERISTICS versus COLLECTOR-EMITTER VOLTAGE

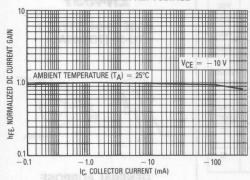


FIGURE 2 — DISSIPATION DERATING CURVE

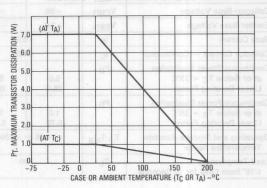


FIGURE 3 — TYPICAL COLLECTOR-CUTOFF CURRENT versus JUNCTION TEMPERATURE

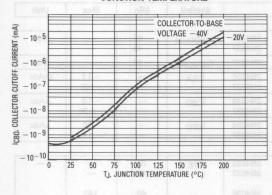


FIGURE 4 — TYPICAL SATURATION-VOLTAGE CHARACTERISTICS

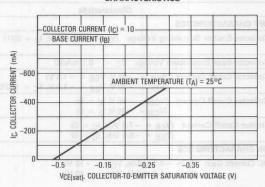


FIGURE 5 — TYPICAL SMALL-SIGNAL BETA CHARACTERISTICS

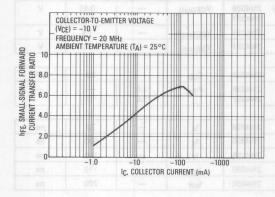
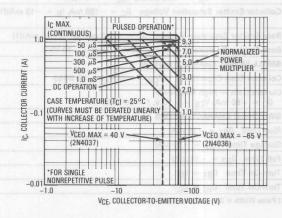


FIGURE 6 — MAXIMUM SAFE OPERATING AREAS (SOA)



Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-80	Vdc
Collector-Base Voltage	VCBO	-80	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current — Continuous	Ic	-1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.25 7.15	Watts mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	8.75 50	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit		
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	140	°C/W		
Thermal Resistance, Junction to Case	RAIC	20	°C/W		

2N4405

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





GENERAL PURPOSE TRANSISTORS

PNP SILICON

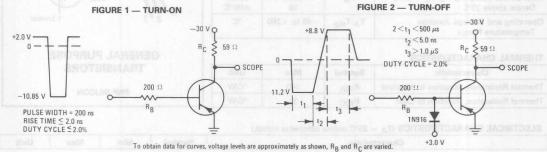
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				Kin P
Collector-Emitter Breakdown Voltage(1) (I _C = −10 mAdc, I _B = 0)	V(BR)CEO	-80	-	Vdc
Collector-Base Breakdown Voltage (I _C = -10 μAdc, I _E = 0)	V(BR)CBO	-80		Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc, I_C = 0$)	V(BR)EBO	-5.0	RUSE	Vdc
Collector Cutoff Current (V _{CB} = -60 Vdc, I _E = 0)	Ісво		- 25	nAdc
Emitter Cutoff Current (VEB = -3.0 Vdc, IC = 0)	I _{EBO}		- 25	nAdc
ON CHARACTERISTICS				0
DC Current Gain	hFE	75 100 100 50	= =	0
Collector-Emitter Saturation Voltage ($I_C = -10 \text{ mAdc}$, $I_B = -1.0 \text{ mAdc}$)(1) ($I_C = -150 \text{ mAdc}$, $I_B = -15 \text{ mAdc}$)(1) ($I_C = -500 \text{ mAdc}$, $I_B = -50 \text{ mAdc}$)(1)	VCE(sat)		-0.15 -0.2 -0.5	Vdc
Base-Emitter Saturation Voltage $(I_C = -10 \text{ mAdc}, I_B = -1.0 \text{ mAdc})(1)$ $(I_C = -500 \text{ mAdc}, I_B = -50 \text{ mAdc})(1)$	VBE(sat)	_ -0.85	-0.8 -1.2	Vdc
Base-Emitter On Voltage (I _C = -150 mAdc, V _{CE} = -1.0 Vdc)(1)	VBE(on)	-	-0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = -50 \text{ mAdc}$, $V_{CE} = -20 \text{ Vdc}$, $f = 100 \text{ MHz}$)	fτ	200	600	MHz
Collector-Base Capacitance ($I_C = -10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz}$)	C _{cb}	Not -	10	pF
Emitter-Base Capacitance (VEB = -0.5 Vdc, IC = 0 , f = 1.0 MHz)	C _{eb}		75	pF

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
SWITCHING CHARA	CTERISTICS			BOYITAR	MUMEX
Delay Time	$(V_{CC} = -30 \text{ Vdc}, V_{BE(off)} = +2.0 \text{ Vdc},$	td	_	15	ns
Rise Time	$I_C = -500 \text{ mAdc}, I_{B1} = -50 \text{ mAdc})$	osovt _r	_	25	ns
Storage Time	$(V_{CC} = -30 \text{ Vdc}, I_{C} = -500 \text{ mAdc},$	t _S	_	175	ns
Fall Time	$I_{B1} = I_{B2} = -50 \text{ mAdc}$	tf	_	35	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUITS



TRANSIENT CHARACTERISTICS

100°C 25°C

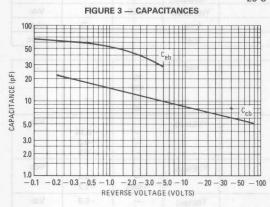


FIGURE 4 — CHARGE DATA 10 7.0 5.0 3.0 CHARGE (nC) 2.0 1.0 0.7 Ö, 0.5 0.3 0.2 0.1 -10-20 -30IC, COLLECTOR CURRENT (mA)

FIGURE 5 — DELAY TIME

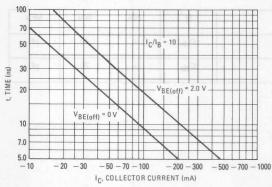


FIGURE 6 — RISE TIME

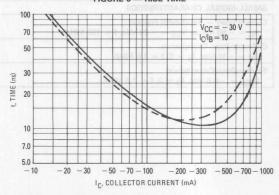


FIGURE 7 — STORAGE TIME

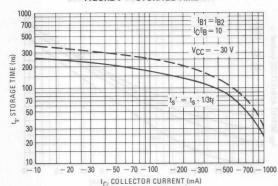
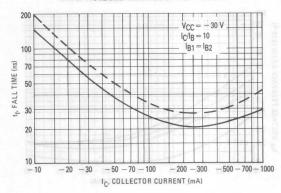


FIGURE 8 — FALL TIME



SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE

 $V_{CE} = 10 \text{ Vdc}, T_A = 25^{\circ}C$

FIGURE 9 — FREQUENCY EFFECTS

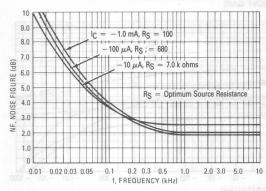
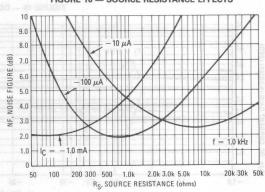


FIGURE 10 — SOURCE RESISTANCE EFFECTS



h PARAMETERS

 $V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz}, T_A = 25^{\circ}\text{C}$

This group of graphs illustrates the relationship of the "h" parameters for this series of transistors. To obtain these curves, 4 units were selected and identified by number — the same units were used to develop curves on each graph.

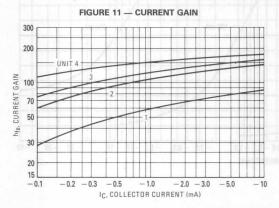
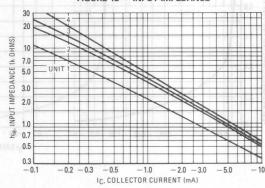


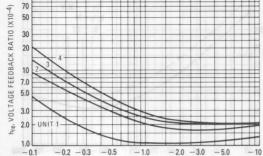
FIGURE 12 — INPUT IMPEDANCE



100

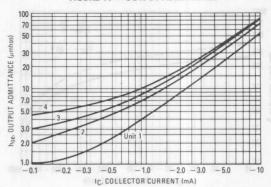


FIGURE 13 — VOLTAGE FEEDBACK RATIO



IC, COLLECTOR CURRENT (mA)

FIGURE 14 — OUTPUT ADMITTANCE



STATIC CHARACTERISTICS

FIGURE 15 — DC CURRENT GAIN

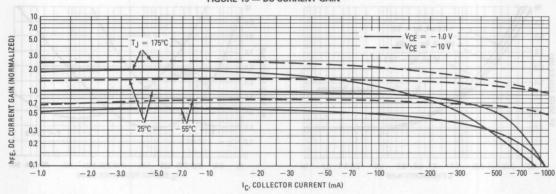
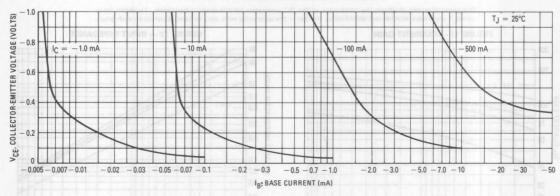
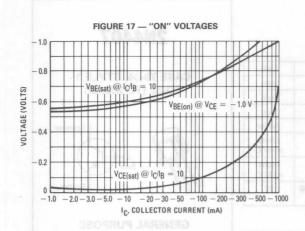


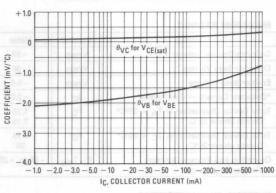
FIGURE 16 — COLLECTOR SATURATION REGION





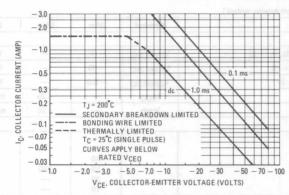






RATINGS AND THERMAL DATA

FIGURE 19 — SAFE OPERATING AREA



The safe operating area curves indicate $1_C \cdot V_{CE}$ limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve. The data of Figure 19 is based upon $T_{J(pk)}=200\,^{\circ}\text{C};\ T_{C}$ is variable depending upon conditions.

The data of Figure 19 is based upon $T_{J(pk)}=200\,^{\circ}\text{C};\ T_{C}$ is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq 200\,^{\circ}\text{C}.\ T_{J(pk)}$ may be calculated from the data in Figure 20. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCBO	-80	Vdc
Collector-Base Voltage	VCEO	-80	Vdc
Emitter-Base Voltage	V _{EBO}	-5.0	Vdc
Collector Current — Continuous	Ic	-2.0	Amps
Total Device Dissipation @ TA = 25°C* Derate above 25°C	PD	1.25 7.15	Watts mW/°C
Total Device Dissipation @ T _C = 25°C* Derate above 25°C	PD	8.75 50	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	140	°C/W
Thermal Resistance to Case	$R_{\theta JC}$	20	°C/W

2N4407

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





GENERAL PURPOSE TRANSISTOR

PNP SILICON

Characteristic	Symbol	Min	Max	Uni
OFF CHARACTERISTICS	1111			
Collector-Emitter Breakdown Voltage(1) (I _C = -10 mAdc, I _B = 0)	V(BR)CEO	-80		Vdc
Collector-Base Breakdown Voltage (I _C = -10 μAdc, I _E = 0)	V(BR)CBO	-80	-	Vdc
Emitter-Base Breakdown Voltage ($I_E = -10 \mu Adc$, $I_C = 0$)	V(BR)EBO	-5.0	<u>-</u>	Vdc
Collector Cutoff Current (V _{CB} = -60 Vdc, I _E = 0)	ІСВО	14	- 25	nAdc
Emitter Cutoff Current (VEB = -3.0 Vdc, IC = 0)	IEBO	0 1005 = E1	- 25	nAdc
ON CHARACTERISTICS(1)	OBTUME SAN	kanigaor -		5
DC Current Gain $ \begin{aligned} &(I_C = -10 \text{ mAdc, } V_{CE} = -5.0 \text{ Vdc}) \\ &(I_C = -150 \text{ mAdc, } V_{CE} = -5.0 \text{ Vdc}) \\ &(I_C = -500 \text{ mAdc, } V_{CE} = -5.0 \text{ Vdc}) \\ &(I_C = -500 \text{ mAdc, } V_{CE} = -5.0 \text{ Vdc}) \\ &(I_C = -1.0 \text{ Adc, } V_{CE} = -5.0 \text{ Vdc}) \\ &(I_C = -1.5 \text{ Adc, } V_{CE} = -5.0 \text{ Vdc}) \end{aligned} $	V2 - 0.0 - 7.0 - 70.	80 80		_
Collector-Emitter Saturation Voltage $ \begin{pmatrix} I_{C} = -150 \text{ mAdc}, I_{B} = -15 \text{ mAdc} \\ I_{C} = -500 \text{ mAdc}, I_{B} = -50 \text{ mAdc} \\ I_{C} = -1.0 \text{ Adc}, I_{B} = -100 \text{ mAdc} \\ I_{C} = -1.5 \text{ Adc}, I_{B} = -150 \text{ mAdc} \end{pmatrix} $	VCE(sat)	Ξ	-0.2 -0.4 -0.7 -1.5	Vdc
Base-Emitter Saturation Voltage $ \begin{aligned} &(I_C=-150 \text{ mAdc}, I_B=-15 \text{ mAdc}) \\ &(I_C=-1.0 \text{ Adc}, I_B=-100 \text{ mAdc}) \\ &(I_C=-1.5 \text{ Adc}, I_B=-150 \text{ mAdc}) \end{aligned} $	V _{BE} (sat)	_ 	-0.9 -1.3 -1.5	Vdc
Base-Emitter On Voltage (I _C = -500 mAdc, V _{CE} = -1.0 Vdc)	V _{BE(on)}		-1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS	- 61			
Current-Gain — Bandwidth Product ($I_C = -50 \text{ mAdc}$, $V_{CE} = -20 \text{ Vdc}$, $f = 100 \text{ MHz}$)	fT	150	750	MHz
Collector-Base Capacitance (V _{CB} = -10 Vdc, I _E = 0, f = 1.0 MHz)	C _{cb}	-	15	pF
Emitter-Base Capacitance (VEB = -0.5 Vdc, IC = 0, f = 1.0 MHz)	C _{eb}	H 1	160	pF

⁽¹⁾ Pulse Test: Pulse Width \leqslant 300 μs , Duty Cycle \leqslant 2.0%. *Indicates Data in addition to JEDEC Requirements.

- 1000mA

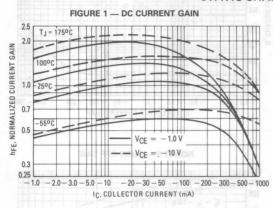
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

	Characteristics	Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS					
Delay Time ATAG 3	$(V_{CC} = -30 \text{ Vdc}, V_{BE(off)} = +2.0 \text{ Vdc},$	td	HOASTED	15	ns
Rise Time	$I_C = -1.0 \text{ Adc}, I_{B1} = -100 \text{ mAdc})$	t _r	_	60	ns
Storage Time	(V _{CC} = -30 Vdc, I _C = -1.0 Adc,	t _S		175	ns
Fall Time	$I_{B1} = I_{B2} = -100 \text{ mAdc}$	tf		50	ns

STATIC CHARACTERISTICS

-0.1 - 0.2

-0.5



/CE, COLLECTOR-EMITTER VOLTAGE (VOLTS) - 500 mA - 100 mA -0.6

FIGURE 2 — COLLECTOR SATURATION REGION

 $T_J = 25^{\circ}C$



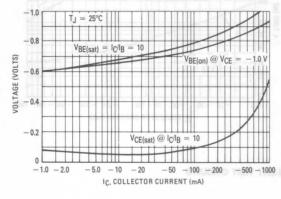


FIGURE 4 — TEMPERATURE COEFFICIENTS

IB, BASE CURRENT (mA)

-5.0 -10

-2.0

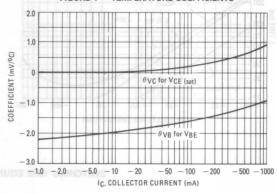
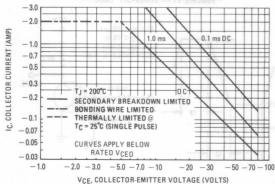


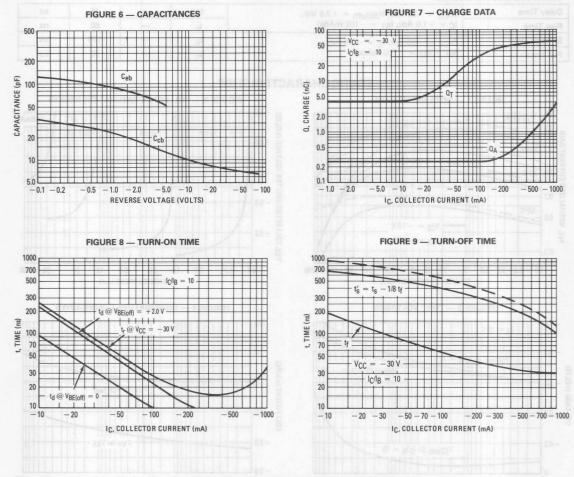
FIGURE 5 - SAFE OPERATING AREA



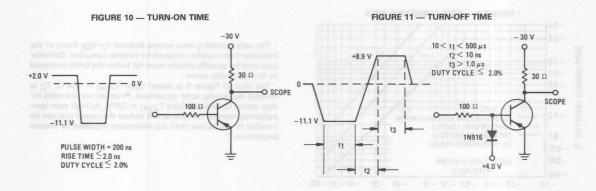
The safe operating area curves indicate I_C-V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 5 is based upon $T_{J(pk)}=200^{\circ}C$; T_{C} is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \le 200^{\circ}C$. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown

TRANSIENT CHARACTERISTICS 25°C 100°C



SWITCHING TIME EQUIVALENT TEST CIRCUITS



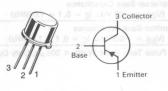
MAXIMOW NATINGS						
Rating	Symbol	2N4931	Unit			
Collector-Emitter Voltage	VCEO	- 250	Vdc			
Collector-Base Voltage	V _{CBO}	-250	Vdc			
Emitter-Base Voltage	VEBO	-4.0	Vdc			
Collector Current — Continuous	Ic	-50	mAdc			
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 5.71	Watt mW/°C			
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	5.0 28.6	Watt mW/°C			
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-65 to +200	°C			

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	°C/W
Thermal Resistance, Junction to Case	$R_{\theta,IC}$	35	°C/W

2N4931

CASE 79-04, STYLE 1 TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTOR

PNP SILICON

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I _C = -10 mAdc, I _B = 0)	V(BR)CEO	-250	_	Vdc
Collector-Base Breakdown Voltage ($I_E = 0$, $I_C = -100 \mu Adc$)	V(BR)CBO	-250	_	Vdc
Emitter-Base Breakdown Voltage ($I_E = -100 \mu Adc, I_C = 0$)	V(BR)EBO	-4.0	-	Vdc
Collector Cutoff Current $(V_{CB} = -150 \text{ Vdc}, I_{E} = 0)$	Ісво	_	-1.0	μAdc
Emitter Cutoff Current $(V_{EB} = -3.0 \text{ Vdc}, I_{C} = 0)$	IEBO	-	-1.0	μAdc
ON CHARACTERISTICS				
DC Current Gain	hFE	20 20 20	200 	_
Collector-Emitter Saturation Voltage(1) (I _C = -10 mAdc, I _B = -1.0 mAdc)	VCE(sat)	_	-5.0	Vdc
Base-Emitter On Voltage (I _C = -10 mAdc, V _{CE} = -10 Vdc)	V _{BE(on)}	-	-1.0	Vdc

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS	Symbol .	loding gnine!				
Current-Gain — Bandwidth Product	abV	- 250	oaoVfT	20	200	MHz
$(I_C = -20 \text{ mAdc}, V_{CE} = -20 \text{ Vdc}, f = 100 \text{ MHz})$	bliV	081-	I mark V		enatioV s	and-motorile
Collector-Base Capacitance (V _{CB} = -20 Vdc, I _E = 0, f = 1.0 MHz)			C _{cb}	-	20	pF
Emitter-Base Capacitance (V _{EB} = -0.5 Vdc, I _C = 0, f = 1.0 MHz)	staW.	0.1	C _{eb}	TA = 25°C	400	pF

(1) Pulse Test	Pulse Width	\leq 300 μ s, [Duty Cycle	$e \le 2.0\%$.
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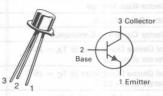
Rating OT 81-01	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	300	Vdc
Collector-Base Voltage	VCBO	300	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	Ic	50	mA
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	500 2.86	mW mW/°C
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.8 10.3	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	8.01°C

THERMAL CHARACTERISTICS

1112111111112 0111111111111111111111111			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	350	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	97	°C/W

2N6431*

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

fints with mith Chi	aracteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				apmorar:	FF CRABB
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	Ууванско	V(BR)CEO	300 (C	nte Jreande	Vdc
Collector-Base Breakdown Voltage (I _C = 0.1 mAdc, I _E = 0)	V(BR)CBO	V(BR)CBO	300	wobits of as as above is	Vdc
Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0)	OBBIRBIV	V(BR)EBO	6.0	Brits <u>Li</u> sown Lm N. Ic. 1	Vdc
Collector Cutoff Current (V _{CB} = 200 Vdc)	080	ICBO	_	0.1	μAdc
Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0)	OBBI	I _{EBO}	- (0	0.1	μAdc
ON CHARACTERISTICS				apprende.	N CHARAC
DC Current Gain (I _C = -1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc)(1) (I _C = 30 mAdc, V _{CE} = 10 Vdc)(1)	目的	hFE	25 40 50	200	fner <u>ur</u> 3 (lc = -1 (lc = -3) (lc = -3)
Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc)(1)	(tea) HJV	VCE(sat)	on V <u>olt</u> age - 2.0 mAde	-0.5	Vdc
Base-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc)(1)	(sec) HBV	V _{BE} (sat)	Voltat <u>os</u> - 2.0 mAdo	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS			SOLI SINGS	DABRIY YUM	HINLL SIGN
Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f =	100 MHz)	relike dur = 1	50	500	MHz
Collector-Base Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 1.0 MHz	do- ²	C _{cb}	10,1 = 1,0 N	4.0	P SOV

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

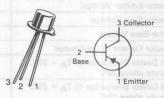
THE DESIGNATION OF THE PARTY OF			
Rating	Symbol	2N6433	Unit
Collector-Emitter Voltage	VCEO	-300	00 Vdc
Collector-Base Voltage	VCBO	-300	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current — Continuous	Ic	-500	mA
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	500 2.86	mW mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.8	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	350	°C/W
Thermal Resistance, Junction to Case	ReJC	97	°C/W

2N6433*

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTOR

PNP SILICON

★This is a Motorola designated preferred device.

shell rath Cha	aracteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				CTERESTICS.	ARAHO TO
Collector-Emitter Breakdown Voltage (I _C = -1.0 mAdc, I _B = 0)	V(88))CEO	V(BR)CEO	-300	obserte uspi	Vdc
Collector-Base Breakdown Voltage $(I_C = -0.1 \text{ mAdc}, I_E = 0)$	V(BR)CBQ	V(BR)CBO	-300	wota la oi8 a nAde, le = 0	Vdc
Emitter-Base Breakdown Voltage $(I_E = -0.1 \text{ mAdc}, I_C = 0)$	У(вя)єво	V(BR)EBO	-5.0	Breaktlown	Vdc
Collector Cutoff Current (V _{CB} = -200 Vdc)	083	ICBO	-	-0.25	μAdc
Emitter Cutoff Current (VEB = -3.0 Vdc, I _C = 0)	069	I _{EBO}	-	-0.1	μAdc
ON CHARACTERISTICS				BOY SUBSYS	N CHARAC
DC Current Gain $(I_C = -1.0 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})$ $(I_C = -10 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})$ $(I_C = -30 \text{ mAdc}, V_{CE} = -10 \text{ Vdc})$	(1)	hFE	25 40 30		C Current (IC = -1 (IC = 10 a
Collector-Emitter Saturation Voltage (I _C = -20 mAdc, I _B = -2.0 mAdc))(1) ⁽¹⁸⁸⁾³³⁴	VCE(sat)	on Voltage	-0.5	Vdc
Base-Emitter Saturation Voltage (I _C = -20 mAdc, I _B = -2.0 mAdc)(1)	VBE(sat)	alteger (1)(deger))	-0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS			ROTTRUMEN	MAL CHARAC	DIR-LIANS
Current-Gain — Bandwidth Product $(I_C = -10 \text{ mAdc}, V_{CE} = -20 \text{ Vdc},$	f = 100 MHz)	fT GHAT DOT	50	500	MHz
Collector-Base Capacitance (V _{CB} = -20 Vdc, I _E = 0, f = 1.0 M	IHz)	C _{cb}	9	6.0	pF

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

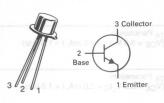
Rating	Symbol	BC 107	BC 108	BC 109C	Unit
Collector-Emitter Voltage	VCEO	45	25	25	Vdc
Collector-Base Voltage	VCBO	50	30	30	Vdc
Emitter-Base Voltage	VEBO	6	5	5	Vdc
Collector Current — Continuous	Ic	0.2			Amp
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.6 3.43		esorci	Watt mW/°C
Total Device Dissipation @ $T_C = 25^{\circ}C$ $T_C = 100^{\circ}C$ Derate above 25°C	PD	5.7		Watt mW/°C	
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200		°C	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	Baic	175	°C/W

BC107, A, B thru BC109C

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



TRANSISTORS
NPN SILICON

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	BARE CAPACITANCE	ROTORLEGS				
Collector Base Leakage Current (IE = 0, V _{CB} = 45 V) (IE = 0, V _{CB} = 45 V, T _{Amb} = 125°C) (IE = 0, V _{CB} = 25 V) (IE = 0, V _{CB} = 25 V, T _{Amb} = 125°C)	BC107 BC107 BC108, BC109C BC108, BC109C	ICBO	=		15 4 15 4	nA μA nA μA
Emitter-Base Breakdown Voltage (I _E = 10 μA, I _C = 0)	BC107 BC108, BC109C	V(BR)EBO	6 5	- Par Par	_	V
Collector Emitter Breakdown Voltage (I _C = 2 mA, I _E = 0)	BC107 BC108, BC109C	V(BR)CEO	45 25		_	V
ON CHARACTERISTICS			- 6			
DC Current Gain (V _{CE} = 5 V, I _C = 2 mA)	BC107 BC108 BC107A BC107B, BC108B BC109C	hFE	110 110 110 200 420		450 800 220 450 800	_
$(V_{CE} = 5 \text{ V}, I_{C} = 10 \mu\text{A})$	BC107B, BC108B BC109C		40 100	=	_	
Base Emitter Saturation Voltage (1) (I _C = 10 mA, I _B = 0.5 mA) (I _C = 100 mA, I _B = 5 mA)	T — E ŠRUDN	VBE(sat)	GW el 148 -	0.7 1.0	0.83	V
Collector Emitter Saturation Voltage (1) (I _C = 10 mA, I _B = 0.5 mA) (I _C = 100 mA, I _B = 5 mA)		VCE(sat)			0.25 0.60	V
Base Emitter On Voltage (I _C = 2 mA, V _{CE} = 5 V) (I _C = 10 mA, V _{CE} = 5 V) (1)	e a 3	V _{BE(on)}	0.55	- 1	0.70 0.77	V
Collector Knee Voltage (IC = 10 mA, IB = the value for which IC = 11 i	mA at V _{CE} = 1 V)	VCE(K)	1	0.4	0.6	V
DYNAMIC CHARACTERISTICS		W 58-1	IIII	384 11		
Transition Frequency (I _C = 10 mA, f = 100 MHz, V _{CE} = 5 V)	25.0	fT	150	300		MHz
Noise Figure (V _{CE} = 5 V, I _C = 0.2 mA, R _g = 2 K Ω) F = 1 kHz, Δ F = 200 Hz	BC109C BC107/108	NF		- 001	4 10	dB

BC107, A, B thru BC109C

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
Output Capacitance (VCB = 10 V, f = 1.0 MHz)	Hat DB O	C _{obo}	Img\$	_	4.5	pF
h _{21e} Parameters (V _{CE} = 5.0 V, I _C = 2.0 mA, f = 1.0 kHz)	BC107/108	h _{21e}	125	<u> </u>	500	l-apposite
	BC107A BC107B, BC108B BC109C	08 0	125 240 450	_	260 500 900	allector-8 nilter-8a
h_{11e} Parameters (V _{CE} = 5.0 V, I _C = 2.0 mA, f = 1.0 kHz)	BC107A BC107B, BC108B BC109C	h _{11e}	1.6 3.2 6.0	0 TA 28°C	4.5 8.5 15	ΚΩ
h_{22e} Parameters (V _{CE} = 5.0 V, I _C = 2.0 mA, f = 1.0 kHz)	BC107A BC107B, BC108B BC109C	h _{22e}	47	TG# 160°L	30 60 110	μhos

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

FIGURE 1 — EMITTER-BASE CAPACITANCE COLLECTOR-BASE CAPACITANCE

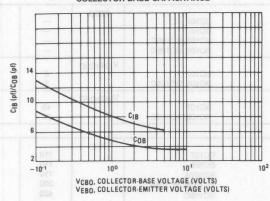


FIGURE 2 — CURRENT GAIN — BANDWIDTH PRODUCT

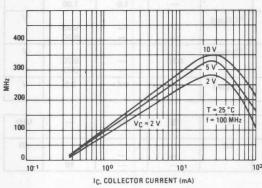
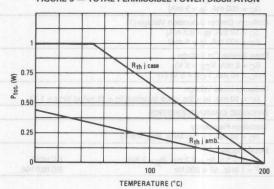


FIGURE 3 — TOTAL PERMISSIBLE POWER DISSIPATION



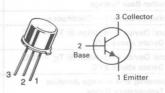
Rating	Symbol	BC 140	BC 141	Unit
Collector-Emitter Voltage	VCEO	40	60	Vdc
Collector-Base Voltage	V _{CBO}	80	100	Vdc
Emitter-Base Voltage	VEBO	sbV 7		Vdc
Collector Current — Continuous	Ic	sbA 1		Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.8 4.6		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	3.7 20		Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200		or a°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	219	W/2° 218
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	™ °C/W

BC140-10, -16 BC141-10, -16

CASE 79-04, STYLE 1 TO-39 (TO-205AD)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N3019 for graphs.

FLECTRICAL CHARACTERISTICS /TA = 25°C upless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	(boto)	$r_{\rm A}=25^{\circ}{\rm C}$ unless otherwise r	SULTONAL	CHARAC	HECTHICA
Collector Cutoff Current (IE = 0, VCE = 60 V)	T _A = 150°C	ICES	10	100 100	nA μA
Collector-Emitter Breakdown Voltag (ICES = 100 µA, IE = 0)	BC140 Series BC141 Series	V(BR)CES	80	morned from	O tot Villo
(IC = 30 mA, IB = 0)	BC140 Series BC141 Series	V(BR)CEO	40 60	ES 80	V
Emitter-Base Breakdown Voltage (IE = 100 μ A, IC = 0)	V(BR)CES	V(BR)EBO	agatloV nwo	nitter Sreakd	3-1015VIIo
ON CHARACTERISTICS		81-1810E tot			
DC Current Gain (1) (I _C = 100 mA, V _{CE} = 1 V) for BC140, 1 for BC140, 1		6F-0812 8 not 9FE 1	63 100	160 250	Collector-En
Collector-Emitter Saturation Voltag (IC = 1 A, IB = 0.1 A)	e(1)	VCE(sat)		1	V
Base-Emitter Voltage(1) (IC = 1 A, VCE = 1 V)	gqd	VBE(on)		2	Varren
SMALL SIGNAL CHARACTERISTIC	CS	norda perde los	V 11/1	304	01 31
Gain Bandwidth Product (IC = 50 mA, VCE = 10 V, f = 20	MHz)	fŢ	50	- <u>- al</u> 40	MHz
Input Capacitance (VEB = 0,5 V, I _C = 0, f = 1 MHz	(no)38 ^v	C _{ib}	(V 0.1	80	pF
Capacitance (IE = 0, V _{CB} = 10 V, f = 1 MHz)	T	Cob	BOTERSTO	25	pF
Turn On Time (I _C = 150 mA, I _{B1} = 7.5 mA)	Cita	ton	= 1,7 0t - :	250	ns
Turn Off Time (IC = 150 mA, IB1 = IB2 = 7.5 m/	A)	toff	(sHA# 0	850	ns

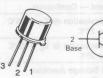
Rating	Symbol	BC 160-16	BC 161–16	Unit
Collector-Emitter Voltage	VCEO	-40	-60	Vdc
Collector-Base Voltage	V _{CBO}	-40	-60	Vdc
Emitter-Base Voltage	VEBO	obV -!	-5.0	
Collector Current — Continuous	Ic	shA − 1.0		Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.8 4.6		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	3.7 20		Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200		°C

THERMAL CHARACTERISTICS

THE MALE OF A BACKETON							
Characteristic	Symbol	Max	Unit				
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	219	°C/W				
Thermal Resistance, Junction to Case	Reic	50	°C/W				

BC160-16 BC161-16

CASE 79-04, STYLE 1 TO-39 (TO-205AD)



AMPLIFIER TRANSISTORS

PNP SILICON

Refer to 2N4405 for graphs.

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	O'Det = AT		(V C8 = 30	V 0 = 311
Collector Cutoff Current IE = 0, VCES = -40 V for BC160-16 VCES = -60 V for BC161-16 VCES = -40 V for BC160-16 TAmb = 150°C VCES = -60 V for BC161-16 TAmb = 150°C	CES SE ICES	own Voltag own Voltag	-100 -100 -100 -100	
Collector-Emitter Breakdown Voltage $I_C = -100 \ \mu\text{A}, I_E = 0$ for BC160–16 for BC161–16	V(BR)CES	-40 -60	e Breakdovin µA, IC = 0) CTERESTICS	MIVE BE
Collector-Emitter Breakdown Voltage(1) $I_C = -10$ mA, $I_B = 0$ for BC160-16 for BC161-16	V(BR)CEO	-40 -60		(10 = 100 tnemV) 3
Emitter-Base Breakdown Voltage $I_E = -100 \ \mu A, I_C = 0$	V(BR)EBO	-5.0	nitter Sateria	3-robello
ON CHARACTERISTICS			IA J. U = BI	
DC Current Gain(1) I _C = -100 mA, V _{CE} = -1.0 V for BC160, BC161, -16	hFE	100	250	A (= 31)
Collector-Emitter Saturation Voltage(1) (I _C = -1.0 A, I _B = -0.1 A)	VCE(sat)	00-1-0	-1.0	V
Base-Emitter Saturation Voltage(1) (I _C = -1.0 A, V _{CE} = -1.0 V)	VBE(on)	- NAM T =	-1.7	nga V
SMALL-SIGNAL CHARACTERISTICS				onglisens
Gain Bandwidth Product (I _C = -50 mA, V _{CE} = -10 V, f = 20 MHz)	fT	50	W DI = 80	MHz
Input Capacitance (V _{EB} = -10 V, f = 1.0 MHz)	C _{ib}	(Am 2	180	pF pF
Output Capacitance (V _{CB} = -10 V, I _E = 0, f = 1.0 MHz)	C _{obo}	m 8.V = g = '309 µs, O	30	pF
Turn On Time (I _C = -100 mA, I _{B1} = -5.0 μ A)	Ton		500	ns
Turn Off Time (I _C = -100 mA, I _{B1} = I _{B2} = -5.0 μ A)	T _{off}		650	ns

⁽¹⁾ Pulsed: Pulse Duration = 300 μ s, Duty Cycle = 2.0%.

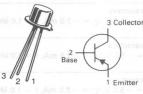
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-45	Vdc
Collector-Emitter Voltage	VCES	-50	Vdc
Collector-Base Voltage	VCBO	-50	Vdc
Emitter-Base Voltage	VEBO	-5	Vdc
Collector Current — Continuous	Ic	-0.2	Amp
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.6 3.43	Watt mW/°C
Total Device Dissipation @ T _C = 25°C T _C = 100°C	PD	1.0	Watt
Derate above 25°C	hase	5.7	mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	175	°C/W

BC177,A,B

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



TRANSISTORS

PNP SILICON

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Leakage Current $(V_{CE} = -20 \text{ V}, I_E = 0)$ $(V_{CE} = -20 \text{ V}, I_E = 0, T_{Amb} = 125^{\circ}\text{C})$	ICES			- 100 - 4	nA μA
Collector Base Breakdown Voltage (IC = -10μ A)	V(BR)CBO	-50			V
Collector Emitter Breakdown Voltage ($I_C = -2.0 \text{ mA}, I_E = 0$)	V(BR)CEO	-45			٧
Emitter Base Breakdown Voltage ($I_E = -10 \mu A, I_C = 0$)	V(BR)EBO	-5.0			٧
ON CHARACTERISTICS					
DC Current Gain BC177 $(I_C = -2.0 \text{ mA, V}_{CE} = -5.0 \text{ V})$ A Group B Group	hFE	120 120 180		460 220 460	
Collector Emitter Saturation Voltage(1) ($I_C = -10 \text{ mA}, I_B = -0.5 \text{ mA}$) ($I_C = -100 \text{ mA}, I_B = -5.0 \text{ mA}$)	VCE(sat)			-0.2 -0.6	V
Base Emitter Saturation Voltage(1) (I _C = -10 mA, I _B = -0.5 mA) (I _C = -100 mA, I _B = -5.0 mA)	VBE(sat)		-0.7 -0.9	-0.8	٧
Base Emitter on Voltage (I _C = -2.0 mA, V _{CE} = -5.0 V)	V _{BE(on)}	-0.6		- 0.75	٧
Collector Knee Voltage (I _C = -10 mA, I _B = the value for which I _C = -11 mA, at V _{CE} = -1.0 V)	VCE(K)		-0.4	-0.6	٧
DYNAMIC CHARACTERISTICS					
Transition Frequency ($V_{CE} = -5.0 \text{ V, } I_{C} = -10 \text{ mA, } f = 100 \text{ MHz}$)	fΤ	200	300		MHz
Noise Figure (V _{CE} = -5.0 V, I _C = -0.2 mA, R _g = 2 K Ω) F = 1.0 kHz F = 1.0 kHz, F = 200 Hz	NF			4.0 4.0 10	dB

Characteristic			Symbol	Min	Тур	Max	Unit
Output Capacitance (V _{CB} = -10 V, f = 1.0 MHz)	Vde	- 60	C _{obo}		3.5	4.0	pF
h_{21e} Parameters (V _{CE} = -5.0 V, I _C = -2.0 mA, f = 1.0 kHz)	BC177 A Group B Group	-8.2	h _{21e}	125 125 240	Continuous tion @ TA =	500 260 500	ottoelia:
h_{11e} Parameters (V _{CE} = -5.0 V, I _C = -2.0 mA, f = 1.0 kHz)	A Group B Group	3,63	h _{11e}	1.6 3.2	a of ® noise	4.5 8.5	ΚΩ
h_{22e} Parameters (VGE = -5.0 V, IC = -2.0 mA, f = 1.0 kHz)	A Group B Group	IS 7 - 08 to +260	h _{22e}		ne Junction	30 60	μ mhos

1	11	Pulco	Toet.	Pulea	Width.	- 1	300 "	e Duty	Cyclo	≤ 2.0%.
- 1	1/	I uise	Test.	ruise	VVICILII	-	500μ	is, Duly	CYCIE	= 2.0%.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	obV -180	Vdc
Collector-Base Voltage	VCBO	aby -180	Vdc
Emitter-Base Voltage	VEBO	ob∀ −6	Vdc
Collector Current — Continuous	Ic	-0.5	Amp
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.4 2.66	Watt mW/°C
Total Device Dissipation @ $T_C = 25^{\circ}C$ $T_C = 100^{\circ}C$ Derate above 25°C	PD	1.5	Watt
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-65 to +200	or 36°C g

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	R _Ø JC	125	°C/W

BC393

CASE 22-03, STYLE 1 TO-18 (TO-206AA)





HIGH VOLTAGE TRANSISTOR

PNP

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS			200	ACTEMENTS	GAMA SEC
Collector-Emitter Breakdown Voltage(1) (I _C = -10 mA, I _B = 0)	V(BR)CEO	- 180	idasyn Valta	end restimi	Vdc
Collector-Base Breakdown Voltage (I _C = -100 μAdc, I _E = 0)	V(BR)CBO	- 180	own Voltage	lase Bre to	Vdc
Emitter-Base Breakdown Voltage (I _E = -100 μAdc, I _C = 0)	V(BR)EBO	-6	egatio\ nw	ob leanS ea	Vdc
Collector Cutoff Current (V _{CB} = -100 V, I _E = 0)	ICBO		10	- 50	nA
Collector-Emitter Cutoff (VCE = -100 V, I _B = 0) (T _{Amb} = 150°C)	ICEO	Carrie	100	-50	μΑ
ON CHARACTERISTICS(1)			Targes.	on sign coa	NU CHAIR
DC Current Gain (I _C = -10 mA, V _{CE} = -10 V)	hFE	50	100	t Gaill	Curred
Collector-Emitter Saturation Voltage (I _C = -10 mAdc, I _B = -1.0 mAdc)	VCE(sat)	eg	-0.15	-0.3	Vdc
Base-Emitter Saturation Voltage (I _C = -10 mAdc, I _B = -1.0 mAdc)	V _{BE} (sat)		-0.7	-0.9	Vdc
DYNAMIC CHARACTERISTICS			Selections.	trans A classical	711111111111
Current-Gain — Bandwidth Product (I _C = -20 mAdc, V _{CE} = -20 Vdc, f = 20 MHz)	fT	50	110	200	MHz
Output Capacitance (I _E = 0, V _{CB} = -20 Vdc, f = 1.0 MHz)	C _{obo}	Zel/Ad	3.5	n national	pF
Input Capacitance (I _C = 0, V _{EB} = -0.5 Vdc, f = 1.0 MHz)	Cib	44174	75	30/120/20	pF geo pF
Turn-On Time (I _{B1} = -10 mA, I _C = -50 mAdc, V _{CC} = -100 Vdc)	ton		100	smi	ns
Turn-Off Time ($I_{B2} = -10 \text{ mAdc}$, $I_{C} = -50 \text{ mAdc}$, $V_{CC} = -100 \text{ Vdc}$)	^t off		400	n-mi	ns

^{*}Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2%.

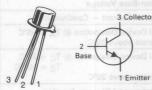
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	180	Vdc
Collector-Base Voltage	Vсво	180	Vdc
Emitter-Base Voltage	VEBO	6	Vdc
Collector Current — Continuous	Ic	0.5	Amp
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.4 2.66	Watt mW/°C
Total Device Dissipation @ $T_C = 25^{\circ}C$ $T_C = 100^{\circ}C$ Derate above 25°C	PD	1.5	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-65 to +200	O.C.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	Rajc	125	°C/W

BC394

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



HIGH VOLTAGE TRANSISTOR

NPN

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS			80	II SIESTUAI	IANO TRI
Collector-Emitter Breakdown Voltage (I _C = 10 mA, I _B = 0)	V(BR)CEO	180	Wildell An	gi Asi Of	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	V _(BR) CBO	180	(0 = 3)	abAu 001	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \mu Adc, I_C = 0$)	V(BR)EBO	6	(0 = 0)	100 pende.	Vdc
Collector Cutoff Current (V _{CB} = 100 V, I _E = 0)	Ісво		(0) =	50	nA
Collector-Emitter Cutoff (VCE = 100 V, IB = 0) (T _{Amb} = 150°C)	ICEO) = 150°C	nAT) (0 =	50	μΑ
ON CHARACTERISTICS(1)			11,16	B raher JA	MRESCO DE
DC Current Gain (I _C = 10 mA, V _{CE} = 10 V)	hFE	50	100	OV Am Of	= 30
Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	V _{CE(sat)}	hkdd	0.15	0.3	Vdc
Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)	V _{BE(sat)}	(abAn	0.7	0.9	Vdc
DYNAMIC CHARACTERISTICS			SULL BUILD	TUAUUANG	SHEWARK E.
Current-Gain — Bandwidth Product (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 20 MHz)	f _{TsHM}	50	110	200	MHz
Output Capacitance (I _E = 0, V _{CB} = 20 Vdc, f = 1.0 MHz)	C _{obo}	(x) 300 (x)	3.5	7	pF
Input Capacitance (I _C = 0, V _{EB} = 0.5 Vdc, f = 1.0 MHz)	C _{ib}	(sHW) p.r	75	= 83V	pF
Turn-On Time (I _{B1} = 10 mA, I _C = 50 mAdc, V _{CC} = 100 Vdc)	(on ^t on ₍₎) =	nde. Vec -	100	- 10 mA, 1c	ns
Turn-Off Time (I _{B2} = 10 mAdc, I _C = 50 mAdc, V _{CC} = 100 Vdc)	toff	mAdo, Vec	400	obAm 01 -	ns

^{*}Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2%.

Rating	Symbol	BCY 70	BCY 71	BCY 72	Unit
Collector-Emitter Voltage	VCEO	-40	-45	- 25	Vdc
Collector-Base Voltage	V _{CBO}	-50	-45	- 25	Vdc
Emitter-Base Voltage	VEBO		-5.0		Vdc
Collector Current — Continuous	Ic	-0.2		Amp	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	360 2.06			mWatt mW/°C
Total Device Dissipation @ $T_C = 25^{\circ}C$ $T_C = 100^{\circ}C$ Derate above 25°C	PD	0.6 3.43		mWatt	
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-6	5 to +	- 200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	Re.IC	292	°C/W

BCY70 thru BCY72

CASE 22-03, STYLE 1 TO-18 (TO-206AA)

3 Collector

1 Emitter 30V)



TRANSISTORS

PNP SILICON

Refer to 2N3799 for graphs.

Characterist	tic	Symbol	Min	Тур	Max	Unit	
OFF CHARACTERISTICS		sound the UV bit - and while her			Shouperi notilen		
Collector-Emitter Breakdown Voltage (I _C = -2.0 mA, I _B = 0)	BCY70 BCY71 BCY72	V(BR)CEO	-40 -45 -25	0 MHz, Vee	- 1.Au 0	licobV - 1g oise Floure (Vos = -	
Collector-Base Leakage Current (I _E = 0, V _{CB} = -50V) (I _E = 0, V _{CB} = -45V) (I _E = 0, V _{CB} = -25V) (I _E = 0, V _{CB} = -40V, T _{Amb} = 100°C) (I _E = 0, V _{CB} = -40V, T _{Amb} = 100°C) (I _E = 0, V _{CB} = -20V, T _{Amb} = 100°C)	BCY70 BCY71 BCY72 BCY70 BCY71 BCY72	I ICBO	(Am s	laz = -1.	- 0.5 - 0.5 - 0.5 - 2.0 - 2.0 - 2.0	μΑ	
$(I_E = 0, V_{CB} = -40V)$ $(I_E = 0, V_{CB} = -40V)$ $(I_E = 0, V_{CB} = -20V)$	BCY70 BCY71 BCY72	rcycle	(shh) 0.1 -	1 ,Am 0.1 -	-10 -50 -50	nA	
Emitter-Base Leakage Current $(V_{EB} = -5.0 \text{ V, I}_{C} = 0)$ $(V_{EB} = -4.0 \text{ V, I}_{C} = 0)$ $(V_{EB} = -4.0 \text{ V, I}_{C} = 0, T_{Amb} = 100^{\circ}\text{C})$	do ^O	IEBO	(2)	apactance 0, f = 1.0 M	-0.5 -10 -2.0	μΑ nA μΑ	
Collector-Emitter Leakage Current (V _{CE} = -50 V, V _{EB} = -3.0 V)	BCY70	ICEX	: WHz) Duty Cycle	= 0, t = 1.0	-20	nA	

ELECTRICAL	CHARACTERISTIC	S (continued) (Ta	= 25°C unless	otherwise noted)

Characteristic			Symbol	Min	Тур	Max	Unit
ON CHARACTERISTICS	Mall	126 300	OF Jordania			Ration	
DC Current Gain (VCE = -1.0 V, IC = -10 uA)	BCY71	-45 - 25	hFE 030	40		get bV total	llector-Err
$(V_{CE} = -1.0 \text{ V, I}_{C} = -10 \mu\text{A})$	BCY/I	45 - 25	VGBO - 50	40		e Voltage	e8-raisell
$(V_{CE} = -1.0 \text{ V}, I_{C} = -100 \mu\text{A})$	BCY70	0.8	OBBY	40		Voltage	aza 8-remi
	BCY71	5.0	21-	80		100 — 1087	Bector Cur
$(V_{CE} = -1.0 \text{ V, I}_{C} = -1.0 \text{ mA})$	BCY70	380	- 69	45		Dissipation	enived le
	BCY71	2,08		90		2.92 46	Perator size
	BCY72	8.0	09	40		Dissipution	sal Device
$(V_{CE} = -1.0 \text{ V}, I_{C} = -10 \text{ mA})(1)$	BCY70	156.5		50		7000 000	of chart
	BCY71	-		100			ods alavol
	BCY72	10 + 200	SS - ptsf d	50		d Storings .	ta pridata datagraa
$(V_{CE} = -1.0 \text{ V}, I_{C} = -50 \text{ mA})(1)$	BCY70			15	anizara:	TOASAR	
Base-Emitter Saturation Voltage(1)	zigU	xeM	V _{BE} (sat)	3	pirei	Characte	V
$(I_C = -50 \text{ mA}, I_B = -5.0 \text{ mA})$ $(I_C = -10 \text{ mA}, I_B = -1.0 \text{ mA})$	BCY70/71 BCY70/71	292	268	-0.6	at notion	-1.2 -0.9	eA Ismae
Collector-Emitter, Saturation Voltage(1) (I _C = -50 mA, I _B = -5.0 mA) (I _C = -10 mA, I _B = -1.0 mA)			V _{CE(sat)}		parestone.	-0.50 -0.25	V
DYNAMIC CHARACTERISTICS	hardward).			70,17			
Transition Frequency	Committee 1		fT	OFF STREET	MILLEON		MHz

DTIVAIVIC CHANACTERISTICS	todrnyth		- of tale of the	PROTECT TO SERVICE STATE OF THE PARTY OF THE		
Transition Frequency (I _C = -10 mA, f = 100 MHz, V _{CE} = -20 V) (I _C = -100 μ A, f = 20 MHz, V _{CE} = -20 V)	All types BCY71 only	fT	250 15	perioV neve	earreser; Medical	MHz
Noise Figure (V _{CE} = -5.0 V, I _C = $-100~\mu$ A, Rg = $2.0~\text{K}\Omega$,	f = 1.0 kHz BCY70/72 BCY71	NF			6.0 2.0	dB 311
Switching Times (I _C = -10 mA, I _{B1} = I _{B2} = -1.0 mA)	BCY70/72 BCY70/72 BCY70/72 BCY70/72 BCY70/72 BCY70/72	ton toff td tr ts tf	(0°08) (0°08)	= dmA ^T = dmA ^T = dmA ^T	65 420 35 35 35 350 80	ns all v 0 = all v 0 = all v 0 = all v 0 = all
h parameters $(V_{CE} = -10 \text{ V, I}_{C} = -1.0 \text{ mA, f} = 1.0 \text{ kHz})$	BCY71	h _{12e} h _{21e} h _{22e} h _{11e}	100 10 2.0		20 X 10 ⁻⁴ 400 60 12	 μs ΚΩ
Common Base Output Capacitance (V _{CB} = -10 V, I _E = 0, f = 1.0 MHz)	UII.5	C _{ob}		16	6.0	pF
Input Capacitance (VEB = -1.0 Vdc, I _C = 0, f = 1.0 MHz)	X39I	C _{ib}	100°C)	J. TArob =	8.0	pF

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

A Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	250	Vdc
Collector-Emitter Voltage	VCER	250	Vdc
Collector-Base Voltage	VCBO	250	Vdc
Emitter-Base Voltage	VEBO	5.0	- Vdc
Collector Current — Continuous	IC	0.1	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.8 4.57	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	5.0 28.6	Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	R _H JC	35	°C/W

BF258

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





HIGH VOLTAGE TRANSISTORS NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

myU xaM gyT Characteris	tic ledmy8	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS				2	DITEMENT DI	NECHALLE
Collector-Emitter Breakdown Voltage(1) (I _C = 30 mAdc, I _B = 0)	V(ER)CEO	V(BR)CEO	250	dow=vonsg 01	iestE= ctri e gi lim a	Vdc
Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0)	OSO(AB)V	V(BR)CBO	250	10,000	plosies = 4 mer plosies = 4 mer	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \mu Adc, I_C = 0$)	V(BR)EBD	V(BR)EBO	5.0	oga st oV re (0 =	ρό (το 14 α μ σ (14 α μ 00	Vdc
Collector Cutoff Current (VCB = 200 Vdc, I _E = 0)	ORDÍ	ICBO	-	1.0	50	nAdc
ON CHARACTERISTICS(1)	083			memu)	harus is thin	a respektive
DC Current Gain (IC = 30 mAdc, VCE = 10 Vdc)		hFE	25	80	egi V_nor Est Cierro	VOS = N CHABA
Collector-Emitter Saturation Voltage (I _C = 30 mAdc, I _B = 6.0 mAdc)	394	VCE(sat)		0.1	1.0	Vdc
DYNAMIC CHARACTERISTICS			2012	HIVE -	33V / n 0	
Current Gain-Bandwidth Product (I _C = 30 mAdc, V _{CE} = 10 Vdc, f = 100	MHz)	fT	740	110	-	MHz
Reverse Transfer Capacitance (V _{CB} = 30 Vdc, I _E = 0, f = 1.0 MHz)	(165):35*	C _{re}	- (1	3.5	al al-Ceru	pF
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	(365) 38 4	C _{cb}		5.5	gi si n om i	pF

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

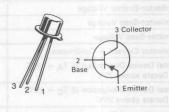
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	- 150	Vdc
Collector-Base Voltage	VCBO	obV - 150	Vdc
Emitter-Base Voltage	VEBO	ob√ −6.0	Vdc
Collector Current — Continuous	lc	-0.1	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.4 2.28	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	1.4 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-65 to +200	%℃

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	438	°C/W
Thermal Resistance, Junction to Case	RAIC	125	°C/W

BFW43

CASE 22-03, STYLE 1 TO-18 (TO-206AA)

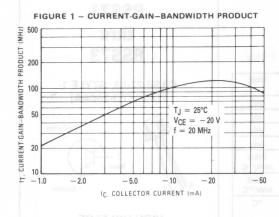


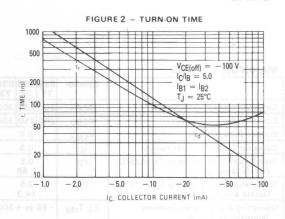
HIGH VOLTAGE TRANSISTOR

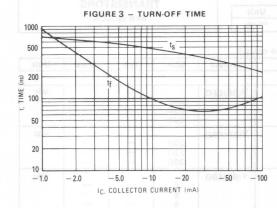
PNP SILICON

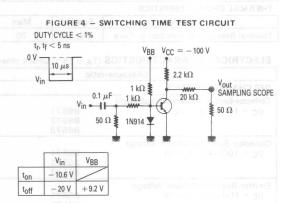
Ball Characteristic Ladange	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS			231	RACTERIST	OFF CHAI
Collector-Emitter Breakdown Voltage (IC = -2.0 mA, IB = 0)	V(BR)CEO	- 150	skdown Ve = 0)	Emitter Br 0 mAdo, te	Vdc
Collector Base Breakdown Voltage (I _C = -100 μAdc, I _E = 0)	V _(BR) CBO	- 150	dows Vela = 0)	Bast Brost 00 pecies to	Vdc
Emitter Base Breakdown Voltage (I _E = -100 μAdc, I _C = 0)	V(BR)EBO	-6.0	own Voltage (0 =	ase Bresko 90 pAsto, 1	Vdc
Collector Cutoff Current (V _{CB} = -100 V, I _E = 0)	ІСВО		(0 = 3	- 10 O	nA
Collector Emitter Cutoff Current (V _{CB} = -100 V, I _B = 0) T _A = 125°C	ICEO		CS(1)	-10	μΑ
ON CHARACTERISTICS			obV 01 = 33	M. obAm 0	E = on
DC Current Gain $(I_C = -1.0 \text{ mA, } V_{CE} = -10 \text{ V})$	hFE	40	eration Vol = 6.0 mag		ollector (IC = 5
$(I_C = -10 \text{ mA}, V_{CE} = -10 \text{ V})(1)$ $(I_C = -10 \mu\text{A}, V_{CE} = -10 \text{ V}, T_A = -55^{\circ}\text{C})$		40	30		
Collector Emitter Saturation Voltage(1) (I _C = -10 mAdc, I _B = -1 mAdc)	VCE(sat)		-0.15	-0.5	Vdc
Base Emitter Saturation Voltage(1) (I _C = -10 mAdc, I _B = -1 mAdc)	V _{BE} (sat)	(1)	-0.7	-0.9	Vdc
DYNAMIC CHARACTERISTICS		(arim o	200	Surviva Mil	(3), (3)
Current Gain Bandwidth Product ($I_C = -10 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$, $f = 20 \text{ MHz}$)	fT	60	110	200	MHz
Output Capacitance (I _E = 0, V _{CB} = -20 Vdc, f = 1.0 MHz)	C _{obo}	-	3.5	7.0	pF
Turn On Time ($I_{B1} = -10$ mA, $I_{C} = -50$ mAdc, $V_{CC} = -100$ Vdc)	ton	-	100	-	ns
Turn Off Time ($I_{B2} = -10 \text{ mAdc}$, $I_{C} = -50 \text{ mAdc}$, $V_{CC} = -100 \text{ Vdc}$)	t _{off}	-	400	-	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2%.









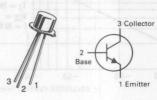
Rating	Symbol	BSS 71	BSS 72	BSS 73	Unit
Collector-Emitter Voltage	VCEO	200	250	300	Vdc
Collector-Base Voltage	Vсво	200	250	300	Vdc
Emitter-Base Voltage	VEBO		6.0		Vdc
Collector Current - Continuous	Ic		0.5	- 1	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD		0.5		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	0.1	2.5 14.3		Watt mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-65	to +	200	°C

THERMAL CHARACTERISTICS

Characteristic Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	RAJC	70	°C/W

BSS71 thru **BSS73**

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



HIGH VOLTAGE **TRANSISTORS**

NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteri	istic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mA, I _B = 0)	BSS71 BSS72 BSS73	V(BR)CEO	200 250 300			Vdc
Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0)	BSS71 BSS72 BSS73	V(BR)CBO	200 250 300			Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \mu Adc, I_C = 0$)	BSS71 BSS72 BSS73	V(BR)EBO	6 6	r- 0.8- r no <u>ro</u> ario:	- 2.0 - - le	Vdc
Collector Cutoff Current (VCB = 150 V, IE = 0) (VCB = 200 V, IE = 0) (VCB = 250 V, IE = 0)	BSS71 BSS72 BSS73	ІСВО	Ξ		50 50 50	nA
Collector-Emitter Cutoff Current (VCE = 150 V, IB = 0) (VCE = 200 V, IB = 0) (VCE = 300 V, IB = 0)	BSS71 BSS72 BSS73	ICEO	Ξ		500 500 500	nA
Emitter-Cutoff Current (V _{EB} = 5.0 Vdc, I _C = 0)	ALL	IEBO			50	nA
ON CHARACTERISTICS						
DC Current Gain $ \begin{array}{ll} \text{IC} = 0.1 \text{ mA, } \text{V}_{\text{CE}} = 1 \text{ V}) \\ \text{(IC} = 1 \text{ mA, } \text{V}_{\text{CE}} = 10 \text{ V}) \\ \text{(IC} = 10 \text{ mA, } \text{V}_{\text{CE}} = 10 \text{ V}) \text{(I)} \\ \text{(IC} = 30 \text{ mA, } \text{V}_{\text{CE}} = 10 \text{ V}) \text{(I)} \\ \text{(IC} = 100 \text{ mA, } \text{V}_{\text{CE}} = 10 \text{ V}) \text{(I)} \\ \end{array} $	BSS71 ALL ALL ALL BSS73	hFE	20 30 50 40	40 45 120 140 35	250	_
Collector-Emitter Saturation Voltage(1) (I _C = 10 mAdc, I _B = 1 mAdc) (I _C = 30 mAdc, I _B = 3 mAdc) (I _C = 50 mAdc, I _B = 5 mAdc) (I _C = 100 mAdc, I _B = 20 mAdc)	ALL ALL ALL BSS73	VCE(sat)	Ξ	0.15 0.25 0.35 0.25	0.3 0.4 0.5	Vdc
Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 1 mAdc) (IC = 30 mAdc, IB = 3 mAdc) (IC = 50 mAdc, IB = 5 mAdc) (IC = 100 mAdc, IB = 10 mAdc)	ALL ALL ALL BSS73	VBE(sat)	Ē	0.7 0.8 0.85 0.9	0.8 0.9 1.0	Vdc

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.) aspect to which the state of the s

Characteristic	2.5	Symbol	Min	Тур	Max	Unit
DYNAMIC CHARACTERISTICS	- 100					
Current Gain Bandwidth Product (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 20 MHz)	2.1 100	ft	50	70	200	MHz
Output Capacitance (IE = 0, V _{CB} = 20 Vdc, f = 1 MHz)	50 3	Cob		3.5	_	pF
Input Capacitance (I _C = 0, V _{EB} = 0.5 Vdc, f = 1 MHz)	- B	Cib	- 1 - (no)	45		pF
Turn On Time (I _{B1} = 10 mA, I _C = 50 mAdc, V _{CC} = 100 Vdc)	-1.0	ton		100	_	ns
Turn Off Time (IB2 = 10 mAdc, IC = 50 mAdc, VCC = 100 Vdc)	a1- E	toff		400		ns

FIGURE 1 - DC CURRENT GAIN

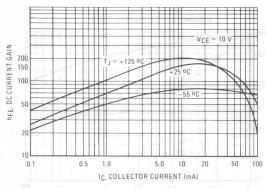


FIGURE 2 - CAPACITANCES

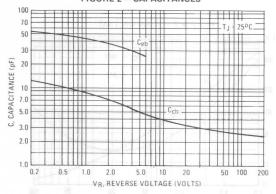


FIGURE 3 - CURRENT-GAIN - BANDWIDTH PRODUCT

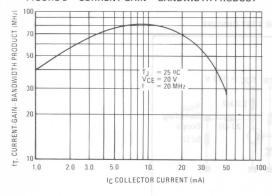
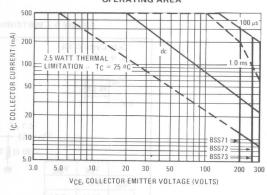
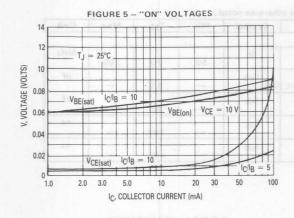
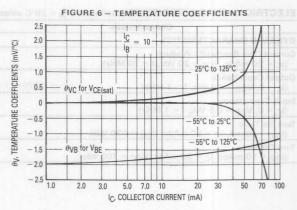


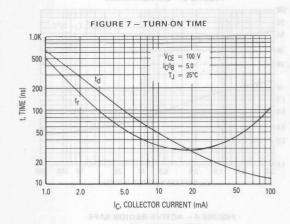
FIGURE 4 – ACTIVE-REGION SAFE OPERATING AREA



BSS71 thru BSS73







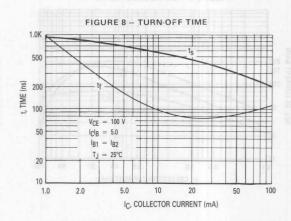
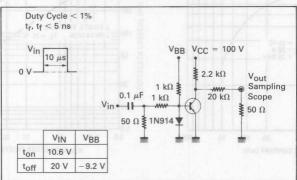


FIGURE 9 - SWITCHING TIME TEST CIRCUIT



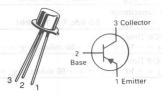
Rating UTT	Symbol	BSS 74	BSS 75	BSS 76	Unit
Collector-Emitter Voltage	VCEO	-200	-250	-300	Vdc
Collector-Base Voltage	VCBO	-200	-250	-300	Vdc
Emitter-Base Voltage	VEBO	dia	-5.0		Vdc
Collector Current — Continuous	Ic		-0.5		Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1107	0.5 2.86		Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	110:	2.5 14.3		Watt mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-6	5 to +	200	°C

THERMAL CHARACTERISTICS

THE THAT OF A TANGET ENGINEE			
Characteristic 4440	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	70	°C/W

BSS74 thru **BSS76**

CASE 22-03, STYLE 1 TO-18 (TO-206AA)



HIGH VOLTAGE TRANSISTORS

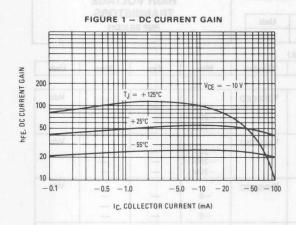
PNP SILICON

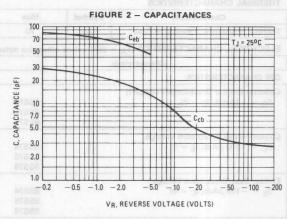
Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	100 2	A Paragraph	- w ##		111	
Collector-Emitter Breakdown Voltage(1) (IC = -10 mA, IB = 0)	BSS74 BSS75 BSS76	V _(BR) CEO	-200 -250 -300	0°851 + =		Vdc
Collector-Base Breakdown Voltage (I _C = -100 μAdc, I _E = 0)	BSS74 BSS75 BSS76	V(BR)CBO	-200 -250 -300) brain		Vdc
Emitter-Base Breakdown Voltage (I _E = -100 μAdc, I _C = 0)	BSS74 BSS75 BSS76	V(BR)EBO	-6 -6 -6	1803 (191 2) (188) 18 – T) — [2- [3-3] —	Vdc
Collector Cutoff Current $ (V_{CB} = -150 \text{ V, } I_E = 0) \\ (V_{CB} = -200 \text{ V, } I_E = 0) \\ (V_{CB} = -250 \text{ V, } I_E = 0) $	BSS74 BSS75 BSS76	Ісво	Z <u>3</u> QAT.	ov <u>v</u> o -	-50 -50 -50	nA
Collector-Emitter Cutoff Current $(V_{CE} = -150 \text{ V}, I_B = 0)$ $(V_{CE} = -200 \text{ V}, I_B = 0)$ $(V_{CE} = -300 \text{ V}, I_B = 0)$	BSS74 BSS75 BSS76	ICEO		= [] -	-500 -500 -500	nA
Emitter-Cutoff Current (VEB = -5.0 Vdc, I _C = 0)	ALL	IEBO			-50	nA
ON CHARACTERISTICS	0 0			- = ant 80 de	sias/	8
DC Current Gain $ \begin{aligned} &(I_C = -0.1 \text{ mA, } V_{CE} = -1.0 \text{ V}) \\ &(I_C = -1.0 \text{ mA, } V_{CE} = -10 \text{ V}) \\ &(I_C = -10 \text{ mA, } V_{CE} = -10 \text{ V})(1) \\ &(I_C = -30 \text{ mA, } V_{CE} = -10 \text{ V})(1) \\ &(I_C = -100 \text{ mA, } V_{CE} = -10 \text{ V})(1) \end{aligned} $	BSS74 ALL ALL ALL BSS76	hFE	20 30 35 35	40 45 50 55 40	150	
Collector-Emitter Saturation Voltage(1) $ \begin{aligned} &(I_C = -10 \text{ mAdc}, I_B = -1.0 \text{ mAdc}) \\ &(I_C = -30 \text{ mAdc}, I_B = -3.0 \text{ mAdc}) \\ &(I_C = -50 \text{ mAdc}, I_B = -5.0 \text{ mAdc}) \\ &(I_C = -100 \text{ mAdc}, I_B = -20 \text{ mAdc}) \end{aligned} $	ALL ALL ALL BSS76	VCE(sat)	(/) (3G)	-0.15 -0.25 -0.35 -0.40	-0.3 -0.4 -0.5	Vdc
Base-Emitter Saturation Voltage(1) (I _C = -10 mAdc, I _B = -1.0 mAdc) (I _C = -30 mAdc, I _B = -5.0 mAdc) (I _C = -50 mAdc, I _B = -5.0 mAdc) (I _C = -100 mAdc, I _B = -10 mAdc)	ALL ALL ALL BSS76	VBE(sat)	=	-0.7 -0.8 -0.85 -0.9	-0.8 -0.9 -1.0	Vdc

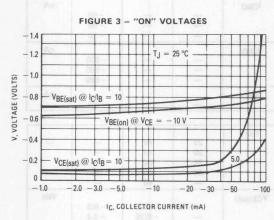
BSS74 thru BSS76

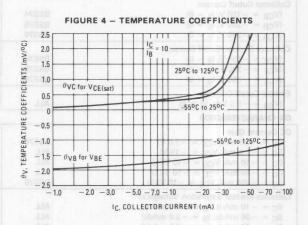
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Тур	Max	Unit
DYNAMIC CHARACTERISTICS	200	Bly let	AT LANGE			BATINGS	MUNIDA
Current-Gain — Bandwidth product (I _C = -20 mAdc, V _{CE} = -20 Vdc, f = 20 MHz)	neti	888	fŢ	50	110	200	MHz
Output Capacitance (I _E = 0, V _{CB} = -20 Vdc, f = 1.0 MHz)	ooV obV	008-	Cob	Voice	3.5	mer Voltage	pF
Input Capacitance (I _C = 0, V _{EB} = -0.5 Vdc, f = 1.0 MHz)	əhV		C _{ib}	063V	45	egailoV	pF
Turn-On Time (I _{B1} = -10 mA, I _C = -50 mAdc, V _{CC} = -100 Vdc)	BuW		ton	Q ² -	100	ninou — men Giadhahaid	ns
Turn-Off Time (I _{B2} = -10 mAdc, I _C = -50 mAdc, V _{CC} = -100 Vdc	itsW		toff	09	400	ve zoro Disseration (i	ns

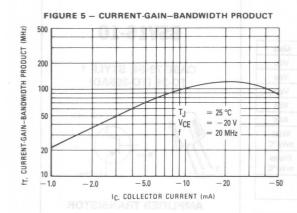


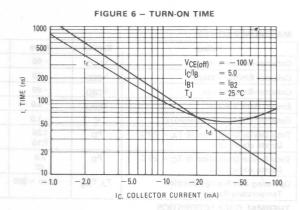


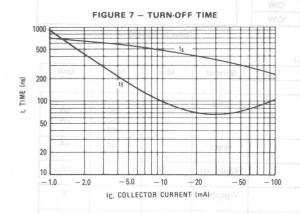


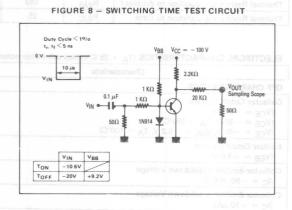


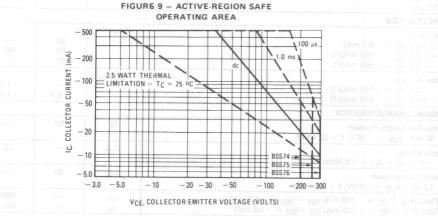
BSS74 thru BSS76











INDAMINON HATINGO		Grand Land	
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	-60	Vdc
Collector-Emitter Voltage	VCES	-60	Vdc
Collector-Base Voltage	VCBO	-60	Vdc
Emitter-Base Voltage	VEBO	-5.0	Vdc
Collector Current — Continuous	Ic	-1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.25 7.15	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	7.0 40	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	140	°C/W
Thermal Resistance, Junction to Case	Reic	25	°C/W

BSV16-10

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





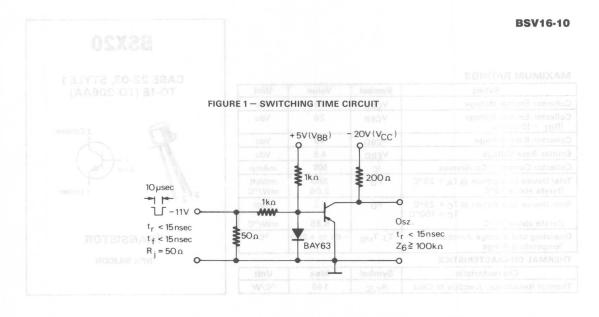
AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N4405 for graphs.

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector Cutoff Current $(V_{CE} = -60 \text{ V})$ $(V_{CE} = -60 \text{ V}, T_{A} = 150^{\circ}\text{C})$ $(V_{CE} = -60 \text{ V}, V_{BE} = -0.2 \text{ V}, T_{A} = 100^{\circ}\text{C})$	ICES		-50 -50 -50	nA μA
Emitter Cutoff Current (VEB = -4.0 V)	IEBO		-50	nA
Collector-Emitter Breakdown Voltage (IC = -50 mA)(1)	V _(BR) CEO	-60	02-	V
Collector-Emitter Breakdown Voltage (IC = -10 µA)	V _{(BR)CES}	-60	31103-31	V
Emitter-Base Breakdown Voltage (I _E = -10 μA)	V(BR)EBO	-5.0	-	٧
ON CHARACTERISTICS ASPA ASPA ASPA ASPA ASPA ASPA ASPA AS				
DC Current Gain (V _{CE} = -1.0 V, I _C = -0.1 mA) (V _{CE} = -1.0 V, I _C = -100 mA)(1) (V _{CE} = -1.0 V, I _C = -500 mA)(1)	hFE	20 63 25	 160 	-
Base-Emitter Voltage (V _{CE} = -1.0 V, I _C = -100 mA)(1) (V _{CE} = -1.0 V, I _C = -500 mA)(1)	V _{BE} (on)	 	-1.0 -1.4	٧
SMALL-SIGNAL CHARACTERISTICS		i i		
Current Gain-Bandwidth Product ($I_C = -50 \text{ mA}, V_{CE} = -10 \text{ V}, f = 20 \text{ MHz}$)	fT	50	_	MHz
Output Capacitance (V _{CB} = -10 V, I _E = 0, f = 1.0 MHz)	C _{ob}	9-	25	pF
Small-Signal Current Gain (IC = -1.0 mA, V _{CE} = -5.0 V, f = 1.0 MHz)	h _{fe}	20	-	_
Turn On Time (Fig. 1) ($I_C = -100 \text{ mA}$, $I_{B1} = I_{B2} = -5.0 \text{ mA}$) Storage Time (Fig. 1) ($I_C = -100 \text{ mA}$, $I_{B1} = I_{B2} = -5.0 \text{ mA}$)	ton t _s	=	500 500	ns
Fall Time (Fig. 1) (I _C = -100 mA, I _{B1} = I _{B2} = -5.0 mA)	tf	-	150	ns

⁽¹⁾ Pulsed: Pulse Duration = 300 μ s, Duty Cycle = 2%.



	V(88)EBO	

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	0 M150/mH	Vdc
Collector-Emitter Voltage (RBE = 10 Ohms)	VCER	20	Vdc
Collector-Base Voltage	Vсво	40	Vdc
Emitter-Base Voltage	VEBO	4.5	Vdc
Collector Current - Continuous	IC	500	mAmp
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	360 2.06	mWatt mW/°C
Total Device Dissipation @ T _C = 25°C T _C = 100°C Derate above 25°C	PD	1.2 6.85	Watt
Derate above 25°C		0.00	mW/°C
Operating and Storage Junction Temperature Range	TJ, Tstg	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	RHIC	146	°C/W

BSX20

CASE 22-03, STYLE 1 TO-18 (TO-206AA)





TRANSISTOR

NPN SILICON

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0) (I _C = 10 mAdc, R _{BE} = 10 Ω)	V(BR)CEO V(BR)CER	15 20		Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$)	V _{(BR)EBO}	4.5		Vdc
Collector Cutoff Current $(V_{CB}=20\ V_{dc}, I_E=0)$ $(V_{CB}=20\ V_{dc}, I_E=0, T_j=150^{\circ}C)$	Ісво		400 30	nAdc μAdc
Collector Cutoff Current $(V_{CE} = 15 \text{ Vdc}, V_{BE} = 0, T_j = 55^{\circ}\text{C})$ $(V_{CE} = 40 \text{ Vdc}, V_{BE} = 0)$	ICES		0.4 1.0	μAdc
Cutoff Current ($V_{CE} = 15 \text{ Vdc}$, $V_{EB} = 3.0 \text{ V}$, $T_j = 55^{\circ}\text{C}$)	ICEX IBEX		0.6 0.6	μAdc
ON CHARACTERISTICS				
DC Current Gain(1)	hFE	40 20 10	120	
Base-Emitter On Voltage (I _C = 30 μ Adc, V _{CE} = 20 Vdc, T _j = 100°C)	V _{BE(on)}		0.35	Vdc
Emitter-Collector Saturation Voltage(1) (I _C = 10 mAdc, I _B = 0.3 mAdc) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc)	VCE(sat)		0.30 0.25 0.60	Vdc
Emitter-Base Saturation Voltage(1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc)	VBE(sat)	0.70	0.85 1.50	Vdc

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS						
Current Gain-Bandwidth Product (I _C = 10 mA, V _{CE} = 10 V, f = 100 MHz)	ziell	l euleV	f _T	500	BOUT I	MHz
Output Capacitance (V _{CB} = 5.0 V, I _E = 0, f = 1.0 MHz)	abV	2.0	C _{obo}		4.0	pF
Input Capacitance (VEB = 1.0 V, I _C = 0, f = 1.0 MHz)	noV.	8	C _{ibo}		4.5	PF PSI
Time (I _C = 10 mA, I _{B1} = I _{B2} = 10 mA)	traVV	8.0	t _S	ndgos pTA = 25°S	1.3	ns
Turn-On Time (I _C = 10 mA, I _{B1} = 3.0 mA) (I _C = 100 mA, I _{B1} = 40 mA)	De January	-56 to +175	ton	naitha	12 7.0	ns na produce
Turn-Off Time (I _C = 10 mA, I _{B1} = 3.0 mA, I _{B2} = -1.5 mA)	sinti	Wew	toff	8000 B	18	ns
$(I_C = 100 \text{ mA}, I_{B1} = 40 \text{ mA}, I_{B2} = -20 \text{ mA})$			- ALL 69 110	HidmA of equi	21	Head Bleens

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2%.

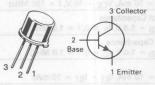
Rating	Symbol	Value	Unit	
Collector-Emitter Voltage	VCEO	65	Vdc	
Collector-Base Voltage	VCBO	65	Vdc	
Emitter-Base Voltage	VEBO	5	Vdc	
Collector Current - Continuous	IC	0.6	Adc	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	0.6 3.43	Watt mW/°C	
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-55 to +175	°C	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	RHJA	292	°C/W

CV12253

CASE 79-04, STYLE 1 TO-39 (TO-205AD)



AMPLIFIER TRANSISTOR

NPN SILICON

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage(1) (IC = 10 mA, IB = 0)	VCEO(sus)	65		V
Collector Cutoff Current (V _{CB} = 50 V, I _E = 0)	ІСВО		20	nA
Emitter Cutoff Current (I _{EBO} (1) V _{EB} = 3 V, I _C = 0) (I _{EBO} (2) V _{EB} = 5 V, I _C = 0)	IEBO		20	nΑ μΑ
Collector Cutoff Current (VCE = 50 V, TA = 100°C)	ICEO		80	μА
ON CHARACTERISTICS				
DC Current Gain	hFE	40 50 25 35	200 —	
Base-Emitter Saturation Voltage(1) (I _C = 30 mA, I _B = 1 mA) (I _C = 150 mA, I _B = 15 mA)	VBE(sat)		0.9	V
SMALL SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 50$ mA, $V_{CE} = 10$ V, $f = 20$ MHz)	fT	60		MHz
Storage Time $(VCC = 45 \text{ V}, IC = 100 \text{ mA}, IB_1 = IB_2 = 10 \text{ mA})$	t _S	172	550	ns
Output Capacitance (VCB = 10 V, f = 1 MHz)	C _{ob}		20	pF

⁽¹⁾ Pulsed: Pulse Duration = 300 μ s, Duty Cycle = 2%.

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	VCEO	150	Vdc
Emitter-Base Voltage	VEBO	5.0	Vdc
Collector Current — Continuous	Ic	200	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 5.71	Watt mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W

MM3001

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





GENERAL PURPOSE TRANSISTORS NPN SILICON

Characte	eristic	toarrive	Symbol	Min	Max	Unit
OFF CHARACTERISTICS					0-41121113	GARANO 1
Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0)	UR .	OBD(BB)V	V _(BR) CEO	150	10 = 1	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0)	08	(SB)CES	V(BR)EBO	5.0	(t = 5, 7, 1)	Vdc
Collector Cutoff Current (VCB = 75 Vdc, IF = 0)	08	V(88)C8O	Ісво	ageno	1.0	μAdc
(V _{CB} = 100 Vdc, I _E = 0)					oV mwetz es	itter-Buse
ON CHARACTERISTICS					(0	AND N = 3
DC Current Gain (I _C = 10 mAdc, V _{CE} = 10 Vdc)	_	0801	hFE	20	(C = 3! 2b	Title Box
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 M	MHz)	easi	fT	150	.6 = _0. 1 merco 1	MHz
Output Capacitance (VCB = 20 Vdc, I _E = 0, f = 100 kHz)			C _{obo}	-	7.0	pF

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

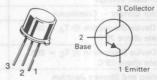
Rating	Symbol	MM3725	Unit
Collector-Emitter Voltage	VCEO	40	Vdc
Collector-Base Voltage	VCBO	80	Vdc
Emitter-Base Voltage	VEBO	6.0	Vdc
Collector Current — Continuous	Ic	500	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 5.71	Watts mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +200	- O°C -

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	°C/W
Thermal Resistance, Junction to Case	R ₀ JC	35	°C/W

MM3725*

CASE 79-04, STYLE 1 TO-39 (TO-205AD)



SWITCHING TRANSISTOR

NPN SILICON

★This is a Motorola designated preferred device.

Characteristic	Landaudi III	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					2011/20037	AASIANA 2
Collector-Emitter Breakdown Voltage (1) (I _C = 10 mAdc, I _B = 0)	999(88)V	V(BR)CEO	40	vor Voltage(ter Everid	Vdc
Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, V _{BE} = 0)	V(RP)EBG	V(BR)CES	80	egatiov	nwoblets	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu Adc, I_E = 0$)	onol	V(BR)CBO	80		menuo fic	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0)		V(BR)EBO	6.0	- (= j⊢bV(Vdc
Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 40 Vdc, I _E = 0)	399	ІСВО		0.12	1.7	μAdc
$(V_{CB} = 60 \text{ Vdc}, I_{E} = 0 \text{ T}_{A} = 100^{\circ}\text{C})$ $(V_{CB} = 60 \text{ Vdc}, I_{E} = 0, T_{A} = 100^{\circ}\text{C})$			=	PLEASED OF	120	nent-State
Collector Cutoff Current (V _{CE} = 80 Vdc, V _{EB} = 0) (V _{CE} = 50 Vdc, V _{EB} = 0)	90%	ICES	(0HM 001	0.15	10 —	μAdc
Base Current $(V_{CE} = 50 \text{ V}, V_{EB} = 0)$ $(V_{CE} = 80 \text{ V}, V_{EB} = 0)$		IB ACO.	≥ eloy3 ytu	s 30 0 us D	10	μAdc
ON CHARACTERISTICS(1)						
DC Current Gain $ \begin{aligned} &(I_C = 10 \text{ mAdc, } V_{CE} = 1.0 \text{ Vdc}) \\ &(I_C = 100 \text{ mAdc, } V_{CE} = 1.0 \text{ Vdc}) \\ &(I_C = 100 \text{ mAdc, } V_{CE} = 1.0 \text{ Vdc}, \\ &(I_C = 300 \text{ mAdc, } V_{CE} = 1.0 \text{ Vdc}) \\ &(I_C = 500 \text{ mAdc, } V_{CE} = 1.0 \text{ Vdc}) \\ &(I_C = 500 \text{ mAdc, } V_{CE} = 1.0 \text{ Vdc}, \\ &(I_C = 800 \text{ mAdc, } V_{CE} = 2.0 \text{ Vdc}) \\ &(I_C = 800 \text{ mAdc, } V_{CE} = 2.0 \text{ Vdc}) \\ &(I_C = 800 \text{ mA, } V_{CE} = 2.0 \text{ Vd}) \\ &(I_C = 1.0 \text{ Adc, } V_{CF} = 5.0 \text{ V}) \\ &(I_C = 1.0 \text{ Adc, } V_{CF} = 5.0 \text{ V}) \end{aligned} $		hFE	30 60 30 40 35 20 25 30 20 25		150 — — — — — —	

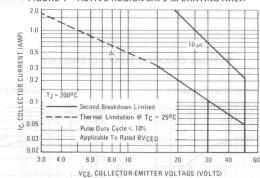
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

	Characteristic		Symbol	Min	Тур	Max	Unit
Collector-Emitte	r Saturation Voltage(1)	To the second	V _{CE(sat)}				Vdc
$(I_C = 10 \text{ mAd})$	c, I _B = 1.0 mAdc)		OL(SUL)	-	0.17	0.25	100
$(I_C = 100 \text{ mA})$	dc, I _B = 10 mAdc)				0.19	0.26	
(IC = 300 mA	dc, I _B = 30 mAdc)		Vo.	BOV -	0.25	0.40	1.7
	dc, I _B = 50 mAdc)				0.30	0.52	30
	dc, I _B = 80 mAdc)			+	0.43	0.80	1
$(I_C = 1.0 \text{ mAc})$	lc, I _B = 100 mAdc)	1		-	0.55	0.95	
Base-Emitter Sa	turation Voltage(1)		V _{BE} (sat)				Vdc
	c, I _B = 1.0 mAdc)					0.76	0.0
	dc, IB = 10 mAdc)		1444			0.86	
	dc, I _B = 30 mAdc)			1	-	1.1	100
	dc, l _B = 50 mAdc)			0.8	1	1.1	
	dc, I _B = 80 mAdc)			-	-	1.5	1 11
(I _C = 1.0 Adc	, I _B = 100 mAdc)				1/1	1.7	-
SMALL-SIGNAL	CHARACTERISTICS						
	Bandwidth Product(2)	01	roor frame	300	0.91 - 0.8	20 —	MHz
$(I_C = 50 \text{ mAd})$	c, $V_{CE} = 10 \text{ Vdc}$, $f = 100 \text{ MHz}$)			LAWLYSTEE	un atemperatur		
Output Capacita (V _{CB} = 10 Vd	nce c, I _E = 0, f = 1.0 MHz)		Cobo	PRATIQN R	TAS ROTAS	10	pF RUBIA
Input Capacitano (V _{EB} = 0.5 Vo	ce dc, I _C = 0, f = 1.0 MHz)	7354	C _{ibo}	mi <u>n</u> ii	1	55	рF
SWITCHING C	HARACTERISTICS	10.10	2982 + 17			9	
Delay Time	(V _{CC} = 30 Vdc, V _{BE(off)} = -3.8 Vdc,	t _d		5.0	1	0	ns
Rise Time	$I_C = 500 \text{ mAdc}, I_{B1} = 50 \text{ mAdc})$	t _r		15	3	0	ns
Turn-On Time	(Figures 8, 10)	ton		20	3	5	ns
Storage Time	(V _{CC} = 30 Vdc, I _C = 500 mAdc,	ts	L. A.O. T. (1) settlette	35	5	0	ns
Fall Time	$I_{B1} = I_{B2} = 50 \text{ mAdc}$	tf	The same	20	2	5	ns
Turn-Off Time	(Figures 9, 10)	toff	1	50	6	0	ns

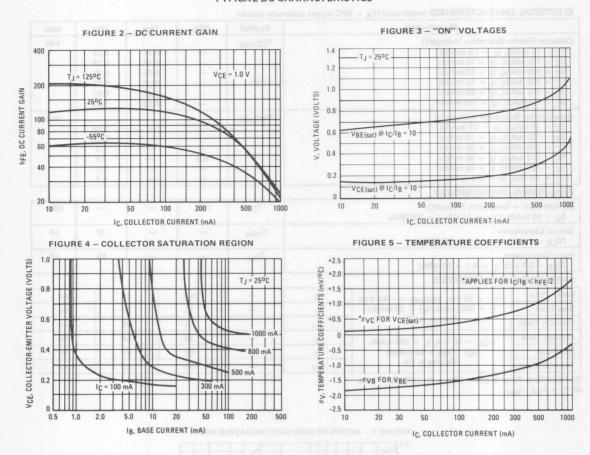
(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle = 1.0%

(2) $f_T = |h_{fe}| \cdot f_{test}$

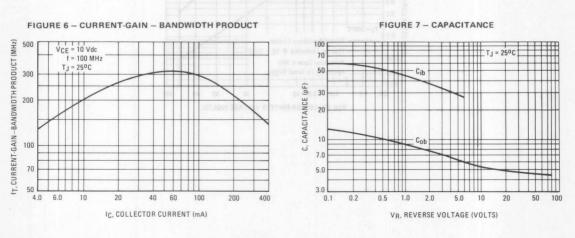




TYPICAL DC CHARACTERISTICS



TYPICAL DYNAMIC CHARACTERISTICS



MM3725

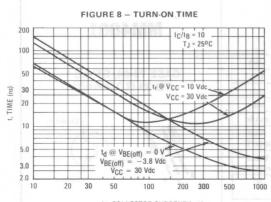
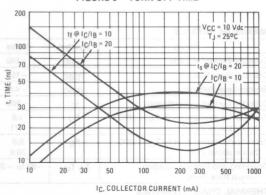


FIGURE 9 - TURN-OFF TIME



IC, COLLECTOR CURRENT (mA)

FIGURE 10 - SWITCHING TIME TEST CIRCUIT

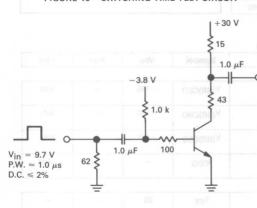
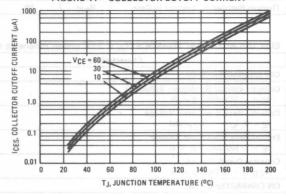


FIGURE 11 - COLLECTOR CUTOFF CURRENT



Rating	Symbol	Value	Unit			
Collector-Emitter Voltage	VCEO	- 150	Vdc			
Collector-Base Voltage	VCBO	-150	Vdc			
Emitter-Base Voltage	VEBO	-4.0	Vdc			
Collector Current — Continuous	Ic	-500	mAdc			
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 5.71	Watt mW/°C			
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	5.0 28.6	Watts mW/°C			
Operating and Storage Junction Temperature Range	TJ, T _{stg}	-65 to +200	°C			

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	292	°C/W
Thermal Resistance, Junction to Case	Reic	58	°C/W

MM4001

CASE 79-04, STYLE 1 TO-39 (TO-205AD)





GENERAL PURPOSE TRANSISTORS

PNP SILICON

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	0-4-6	12.50		
Collector-Emitter Breakdown Voltage(1) $(I_C = -10 \text{ mAdc}, I_B = 0)$	V(BR)CEO	- 150	-	Vdc
Collector-Base Breakdown Voltage (I _E = 0, I _C = -100 μAdc)	V _(BR) CBO	- 150	-	Vdc
Emitter-Base Breakdown Voltage ($I_E = -100 \mu Adc$, $I_C = 0$)	V _{(BR)EBO}	-4.0	-	Vdc
Collector Cutoff Current $(V_{CB} = -75 \text{ Vdc}, I_{E} = 0)$	СВО		-1.0	μAdc
ON CHARACTERISTICS	-			
DC Current Gain(1) ($I_C = -10 \text{ mAdc}$, $V_{CE} = -10 \text{ Vdc}$)	hFE	20	-	-
Collector-Emitter Saturation Voltage(1) (IC = -10 mAdc, IB = -1.0 mAdc)	V _{CE(sat)}		-0.6	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V _{CB} = -20 Vdc, I _E = 0, f = 1.0 MHz)	C _{obo}	-	10	pF

⁽¹⁾ Pluse Test: PW \leq 300 μ s, Duty Cycle \leq 2.0%.

Section 4

Small-Signal Field-Effect Transistors

In Brief . . .

The data sheets on the following pages are designed to emphasize those FETs that by virtue of widespread industry use, ease of manufacture, and low relative cost, merit first consideration for new equipment design.

CAUTION:

Static electricity is a surface phenomenon which most commonly occurs when two dissimilar materials come into contact and then separate. Electro Static Discharge (ESD) damage of semiconductor components by operating personnel is quickly becoming a very prominent and significant problem. From simple bipolar designs to sensitive MOSFET structures, ESD has its unforgiving effect of degradation or destruction.

Motorola believes it is important to extend any emphasizing note of cautiousness when handling and testing ANY FET product. Precautions include, but are not limited to, the implementation of static safe workstations and proper handling techniques. Additionally, it is very important to keep FET devices in their antistatic shipping containers and away from static-generating materials.

NOTE: All SOT-23 package devices have had a "T1" suffix added to the device title.



EMBOSSED TAPE AND REEL

SOT-23 and SOT-223 packages are available only in Tape and Reel. Use the appropriate suffix indicated below to order any of the SOT-23 and SOT-223 packages. (See Section 6 on Packaging for additional information).

SOT-23: available in 8 mm Tape and Reel

Use the device title (which already includes the "T1" suffix) to order the 7 inch/3000 unit reel. Replace the "T1" suffix in the device title with a "T3" suffix to order the 13 inch/10,000 unit reel.

SOT-223: available in 12 mm Tape and Reel

Use the device title (which already includes the "T1" suffix) to order the 7 inch/1000 unit reel. Replace the "T1" suffix in the device title with a "T3" suffix to order the 13 inch/4000 unit reel.

RADIAL TAPE IN FAN FOLD BOX OR REEL

TO-92 packages are available in both bulk shipments and in Radial Tape in Fan Fold Boxes or Reels. Fan Fold Boxes and Radial Tape Reel are the best methods for capturing devices for automatic insertion in printed circuit boards.

TO-92: available in Fan Fold Box

Add an "RLR" suffix and the appropriate Style code* to the device title to order the Fan Fold box.

available in 365 mm Radial Tape Reel

Add an "RLR" suffix and the appropriate Style code* to the device title to order the Radial Tape Reel.

*Refer to Section 6 on Packaging for Style code characters and additional information on ordering requirements.

DEVICE MARKINGS/DATE CODE CHARACTERS

The SOT-23 package has a device marking and a date code etched on the device. The generic example below depicts both the device marking and a representation of the date code that appears on the SOT-23 package.



The "D" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

2N5457*

CASE 29-04, STYLE 5 TO-92 (TO-226AA)





JFETs GENERAL PURPOSE

N-CHANNEL — DEPLETION

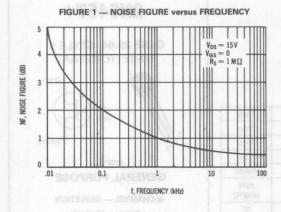
★This is a Motorola designated preferred device.

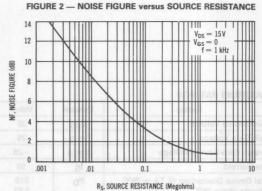
MAXIMUM RATINGS

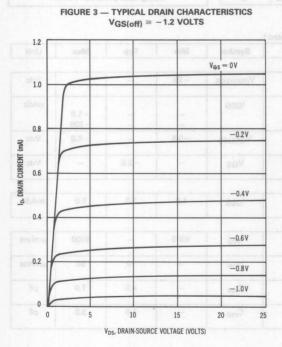
Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	25	Vdc
Drain-Gate Voltage	V _{DG}	25	Vdc
Reverse Gate-Source Voltage	VGSR	- 25	Vdc
Gate Current	IG	10	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	P _D	310 2.82	mW mW/°C
Junction Temperature Range	TJ	125	°C
Storage Channel Temperature Range	T _{stg}	-65 to +150	°C

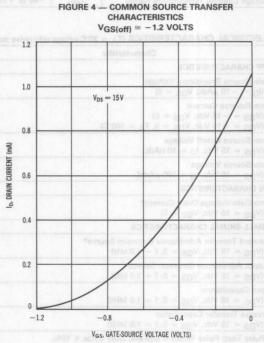
Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS		V0 - 258				
Gate-Source Breakdown Voltage ($I_G = -10 \mu Adc, V_{DS} = 0$)	01	V _(BR) GSS	- 25			Vdc
Gate Reverse Current $(V_{GS} = -15 \text{ Vdc}, V_{DS} = 0)$ $(V_{GS} = -15 \text{ Vdc}, V_{DS} = 0, T_A = 100^{\circ}\text{C})$	80	IGSS	_		-1.0 -200	nAdc
Gate Source Cutoff Voltage (V _{DS} = 15 Vdc, I _D = 10 nAdc)	0.0	VGS(off)	-0.5		-6.0	Vdc
Gate Source Voltage (V _{DS} = 15 Vdc, I _D = 100 μAdc)	10 13	VGS		- 2.5	-	Vdc
ON CHARACTERISTICS	1	10 m				1 8
Zero-Gate-Voltage Drain Current* (V _{DS} = 15 Vdc, V _{GS} = 0)	6	I _{DSS}	1.0	3.0	5.0	mAdc
SMALL-SIGNAL CHARACTERISTICS	0.10					
Forward Transfer Admittance Common Source* (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz)		Yfs	1000	-	5000	μmhos
Output Admittance Common Source* (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz)	2.0	Yos	_	10	50	μmhos
Input Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)		C _{iss}		4.5	7.0	pF
Reverse Transfer Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)	-1.2	C _{rss}	et	1.5	3.0	pF

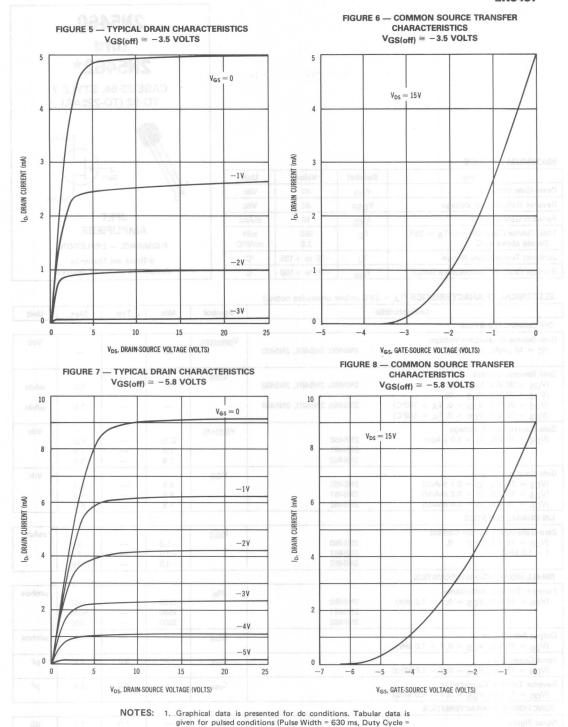
⁽¹⁾ Pulse Test: Pulse Width ≤ 630 ms; Duty Cycle ≤ 10%.











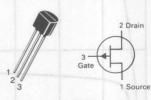
10%). Under dc conditions, self heating in higher IDSS units re-

Figures 8, 9, 10: Data taken in a standard printed circuit with a TO-18 type socket mounting and 1/4" lead length.

duces IDSS (See Figure 10).

2N5460 thru 2N5462*

CASE 29-04, STYLE 7 TO-92 (TO-226AA)



JFET AMPLIFIERS

P-CHANNEL — DEPLETION

★These are Motorola designated preferred devices.

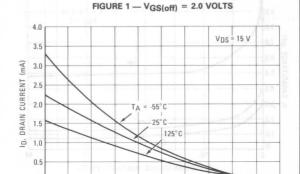
MAXIMUM BATINGS

IVIAAIIVIOIVI HATIINGS						
Rating	Symbol	Value	Unit			
Drain-Gate Voltage	V _{DG}	40	Vdc			
Reverse Gate-Source Voltage	VGSR	40	Vdc			
Forward Gate Current	IG(f)	10	mAdc			
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C			
Junction Temperature Range	TJ	-65 to +135	°C			
Storage Channel Temperature Range	T _{stg}	-65 to +150	°C			

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	Amend 9 Land					6
Gate-Source Breakdown Voltage (I _G = 10 μAdc, V _{DS} = 0)	2N5460, 2N5461, 2N5462	V _(BR) GSS	40	US ENGIL GOV		Vdc
Gate Reverse Current (VGS = 20 Vdc, VDS = 0) (VGS = 30 Vdc, VDS = 0)	2N5460, 2N5461, 2N5462	IGSS	ORAHI CEL <u>S.</u> 8 VO	MONTHY I —	5.0	nAdc
(VGS = 30 Vdc, VDS = 0) (VGS = 20 Vdc, VDS = 0, T _A = 100°C) (VGS = 30 Vdc, VDS = 0, T _A = 100°C)	2N5460, 2N5461, 2N5462	0 3 a V	-	-	1.0	μAdc
Gate Source Cutoff Voltage (V _{DS} = 15 Vdc, I _D = 1.0 μ Adc)	2N5460 2N5461	VGS(off)	0.75 1.0	=	6.0 7.5	Vdc
	2N5462		1.8	1 -	9.0	
Gate Source Voltage (VDS = 15 Vdc, ID = 0.1 mAdc) (VDS = 15 Vdc, ID = 0.2 mAdc) (VDS = 15 Vdc, ID = 0.4 mAdc)	2N5460 2N5461 2N5462	VGS	0.5 0.8 1.5	E	4.0 4.5 6.0	Vdc
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 kHz)	2N5460 2N5461 2N5462	IDSS	-1.0 -2.0 -4.0	=	-5.0 -9.0 -16	mAdc
SMALL-SIGNAL CHARACTERISTICS					111	
Forward Transfer Admittance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 kHz)	2N5460 2N5461 2N5462	Yfs	1000 1500 2000		4000 5000 6000	μmhos
Output Admittance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 kHz)		y _{os}			75	μmhos
Input Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)	1- 1- 1	C _{iss}	al -	5.0	7.0	pF
Reverse Transfer Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)		C _{rss}	nek Watagen	1.0	2.0	pF
FUNCTIONAL CHARACTERISTICS	shulaT banitibara to ad batassi	ion of wash lenin	om2 1	NOTES	W 10 7 40	
Noise Figure (V _{DS} = 15 Vdc, V _{GS} = 0, R _G = 1.0 Megoh	nm, f = 100 Hz, BW = 1.0 Hz)	bros de NF not bros de cond	given 109)	1.0	2.5	dB
Equivalent Short-Circuit Input Noise Voltage (Vps = 15 Vdc, Vgs = 0, f = 100 Hz, BW	= 1.0 Hz)	e _n	Z Figur	60	115	nV/√H

2N5460 thru 2N5462

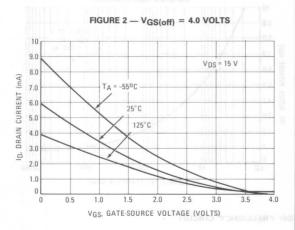
DRAIN CURRENT versus GATE

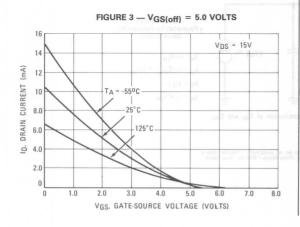


0.8

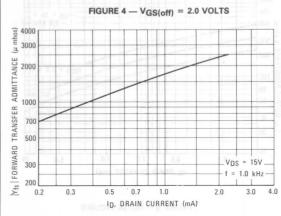
1.0

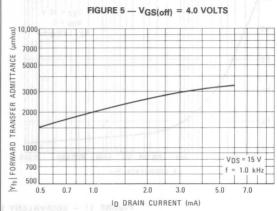
VGS, GATE-SOURCE VOLTAGE (VOLTS)

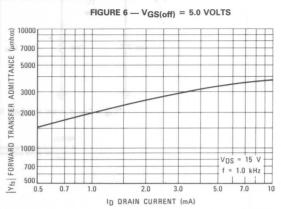




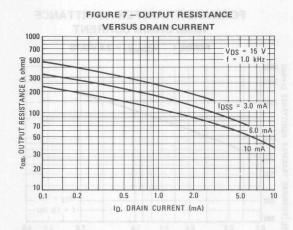
FORWARD TRANSFER ADMITTANCE versus DRAIN CURRENT

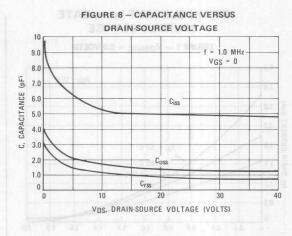


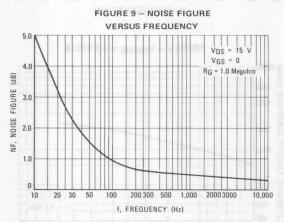




2N5460 thru 2N5462







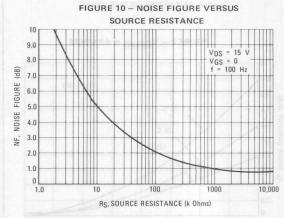
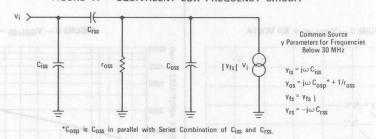


FIGURE 11 - EQUIVALENT LOW FREQUENCY CIRCUIT

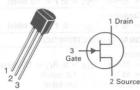


NOTE:

 Graphical data is presented for dc conditions. Tabular data is given for pulsed conditions (Pulse Width = 630 ms, Duty Cycle = 10%).

2N5484 2N5486*

CASE 29-04, STYLE 5 TO-92 (TO-226AA)



JFET VHF/UHF AMPLIFIERS N-CHANNEL — DEPLETION

★These are Motorola designated preferred devices.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V _{DG}	25	Vdc
Reverse Gate-Source Voltage	VGSR	25	Vdc
Drain Current	ID	30	mAdc
Forward Gate Current	IG(f)	10	mAdc
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +150	°C

Characteristic	Symbol	Min	Тур	Max	Unit	
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage (I _G = -1.0μ Adc, V _{DS} = 0)		V _(BR) GSS	- 25	_	-	Vdc
Gate Reverse Current $(V_{GS} = -20 \text{ Vdc}, V_{DS} = 0)$ $(V_{GS} = -20 \text{ Vdc}, V_{DS} = 0, T_A = 100^{\circ}\text{C})$	ER CA(N	IGSS	_	_	-1.0 -0.2	nAdc μAdc
Gate Source Cutoff Voltage (V _{DS} = 15 Vdc, I _D = 10 nAdc)	2N5484 2N5486	VGS(off)	-0.3 -2.0	_	-3.0 -6.0	Vdc
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current (V _{DS} = 15 Vdc, V _{GS} = 0)	2N5484 2N5486	IDSS	1.0 8.0	_	5.0 20	mAdc
SMALL-SIGNAL CHARACTERISTICS			Y 1 6			
Forward Transfer Admittance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 kHz)	2N5484 2N5486	Yfs	3000 4000	_	6000 8000	μmhos
Input Admittance (Vps = 15 Vdc, V _{GS} = 0, f = 100 MHz) (Vps = 15 Vdc, V _{GS} = 0, f = 400 MHz)	2N5484 2N5486	Re(y _{is})	10.1		100 1000	μmhos
Output Admittance $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 1.0 \text{ kHz})$	2N5484 2N5486	yos		_	50 75	μmhos
Output Conductance (VDS = 15 Vdc, VGS = 0, f = 100 MHz) (VDS = 15 Vdc, VGS = 0, f = 400 MHz)	2N5484 2N5486	Re(y _{os})	_	_	75 100	μmhos
Forward Transconductance (Vps = 15 Vdc, Vgs = 0, f = 100 MHz) (Vps = 15 Vdc, Vgs = 0, f = 400 MHz)	2N5484 2N5486	Re(y _{fs})	2500 3500	_	-	μmhos

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Тур	Max	Unit
Input Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)			C _{iss}	-		5.0	pF
Reverse Transfer Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)			C _{rss}	-	-	1.0	pF
Output Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)			Coss	-	-	2.0	pF
FUNCTIONAL CHARACTERISTICS						BRINGS	AUMIKAR
Noise Figure $ \begin{aligned} &(V_{DS}=15 \ Vdc, V_{GS}=0, R_{G}=1.0 \ Megohm, f=0, V_{DS}=15 \ Vdc, _{D}=1.0 \ mAdc, R_{G}\approx1.0 \ k \ ohm, f=100 \ MHz) \end{aligned} $ $ &(V_{DS}=15 \ Vdc, _{D}=1.0 \ mAdc, R_{G}\approx1.0 \ k \ ohm, f=200 \ MHz) \end{aligned} $ $ &(V_{DS}=15 \ Vdc, _{D}=4.0 \ mAdc, R_{G}\approx1.0 \ k \ ohm, f=100 \ MHz) \end{aligned} $ $ &(V_{DS}=15 \ Vdc, _{D}=4.0 \ mAdc, R_{G}\approx1.0 \ k \ ohm, f=400 \ MHz) \end{aligned} $	2N5484 2N5484 2N5484 2N5486 2N5486	00	NF to	canya cov ci ci ci ci ci	4.0 -	2.5 3.0 — 2.0 4.0	dB / sep-pries / day / d
Common Source Power Gain (V _{DS} = 15 Vdc, I _D = 1.0 mAdc, f = 100 MHz) (V _{DS} = 15 Vdc, I _D = 1.0 mAdc, f = 200 MHz) (V _{DS} = 15 Vdc, I _D = 4.0 mAdc, f = 100 MHz) (V _{DS} = 15 Vdc, I _D = 4.0 mAdc, f = 400 MHz)	2N5484 2N5484 2N5486 2N5486	baton e	G _{ps}	16 - 18 10	14 -	25 - 30 20	dB at

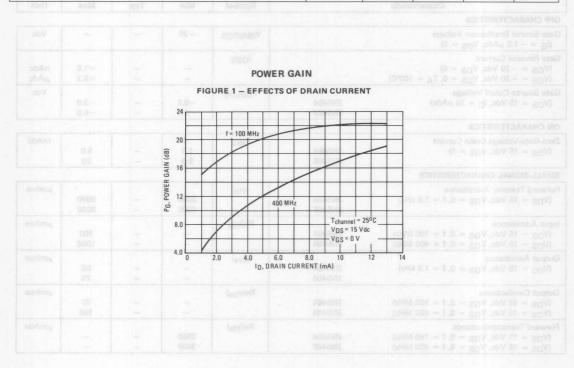
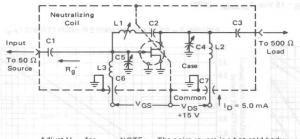


FIGURE 2 - 100 MHz and 400 MHz NEUTRALIZED TEST CIRCUIT



Adjust V_{GS} for $I_D = 50 \text{ mA}$ $V_{GS} < 0 \text{ Volts}$

NOTE:

The noise source is a hot-cold body (AIL type 70 or equivalent) with a test receiver (AIL type 136 or equivalent).

Reference	VALUE			
Designation	100 MHz	400 MHz		
C1	7.0 pF	1.8 pF		
C2	1000 pF	17 pF		
С3	3.0 pF	1.0 pF		
C4	1-12 pF	0.8-8.0 pF		
C5	1-12 pF	0.8-8.0 pF		
C6	0.0015 μF	0.001 μF		
C7	0.0015 µF	0.001 μF		
L1	3.0 µH*	0.2 μH°°		
L2	0.15 μH*	0.03 μΗ**		
L3	0.14 μΗ*	0.022 μH * *		

- *L1 17 turns, (approx. depends upon circuit layout) AWG #28 enameled copper wire, close wound on 9/32" ceramic coil form. Tuning provided by a powdered iron slug.
- L2 4-1/2 turns, AWG #18 enameled copper wire, 5/16" long, 3/8" I.D. (AIR CORE).
- 3-1/2 turns, AWG #18 enameled copper wire, 1/4" long, 3/8" I.D. (AIR CORE).
- **L1 6 turns, (approx. depends upon circuit layout) AWG #24 enameled copper wire, close wound on 7/32" ceramic coil form. Tuning provided by an aluminum slug.
- L2 1 turn, AWG #16 enameled copper wire, 3/8" I.D. (AIR CORE).
- L3 1/2 turn, AWG #16 enameled copper wire, 1/4" I.D. (AIR CORE).

NOISE FIGURE

(T_{channel} = 25°C)

FIGURE 3 - EFFECTS OF DRAIN-SOURCE VOLTAGE

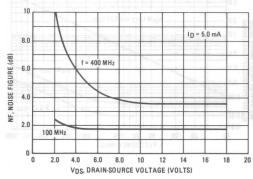
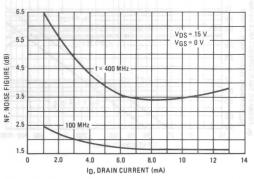
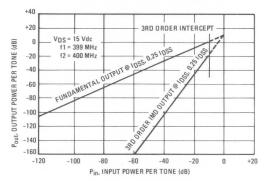


FIGURE 4 - EFFECTS OF DRAIN CURRENT



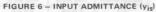
INTERMODULATION CHARACTERISTICS

FIGURE 5 - THIRD ORDER INTERMODULATION DISTORTION



COMMON SOURCE CHARACTERISTICS ADMITTANCE PARAMETERS

(VDS = 15 Vdc, Tchannel = 25°C)



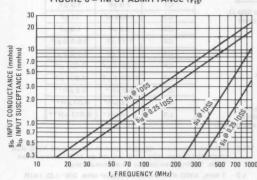


FIGURE 7 - REVERSE TRANSFER ADMITTANCE (yrs)

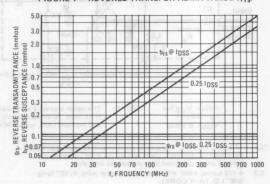


FIGURE 8 - FORWARD TRANSADMITTANCE (yfs)

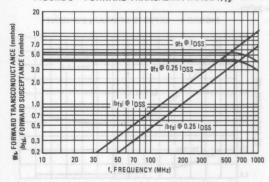
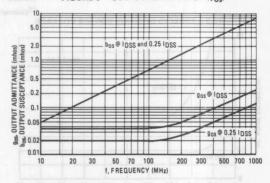
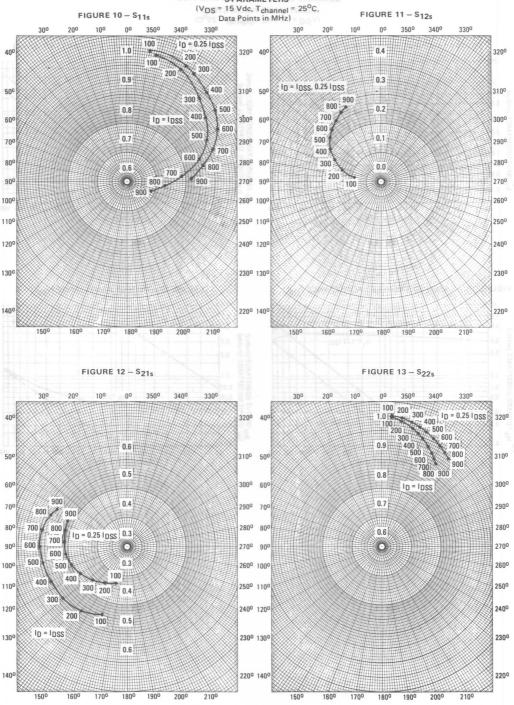


FIGURE 9 - OUTPUT ADMITTANCE (yos)

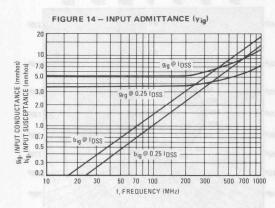


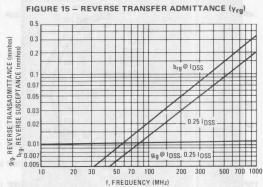
COMMON SOURCE CHARACTERISTICS S-PARAMETERS

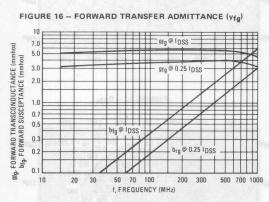


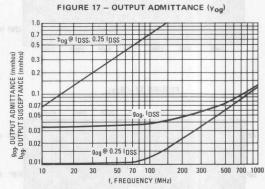
COMMON GATE CHARACTERISTICS

ADMITTANCE PARAMETERS (V_{DG} = 15 Vdc, T_{channel} = 25°C)

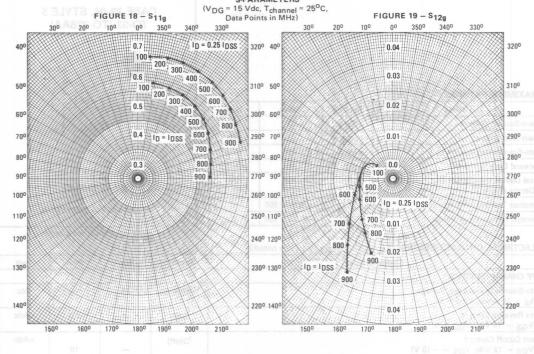


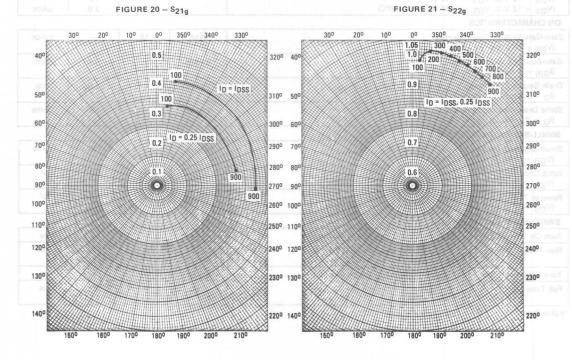






COMMON GATE CHARACTERISTICS S-PARAMETERS





WAXIIIOW HATINGS						
Rating	Symbol	Value	Unit			
Drain-Source Voltage	VDS	25	Vdc			
Drain-Gate Voltage	V _{DG}	25	Vdc			
Gate-Source Voltage	VGS	25	Vdc			
Forward Gate Current	IGF	10	mAdc			
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C			
Junction Temperature Range	TJ	-65 to +150	°C			
Storage Temperature Range	T _{stq}	-65 to +150	°C			

2N5555 CASE 29-04, STYLE 5 TO-92 (TO-226AA) 1 Drain 3 Gate 2 Source

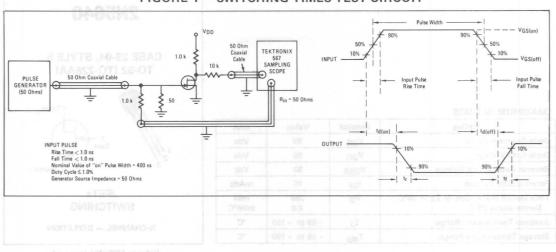
N-CHANNEL — DEPLETION

Refer to 2N5484 for graphs.

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	S Company of the Comp				
Gate-Source Breakdown (I _G = 10 μAdc, V _{DS} =		V(BR)GSS	25	-	Vdc
Gate Reverse Current (VGS = 15 Vdc, VDS	= 0) 1004 0121 0154 0081 0084	IGSS	one: oper	1.0	nAdc
Drain Cutoff Current (V _{DS} = 12 Vdc, V _{GS} (V _{DS} = 12 Vdc, V _{GS}	= -10 V) = -10 V, T _A = 100°C)	ID(off)	_ IGUI NE 20 -	10 2.0	nAdc μAdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain (VDS = 15 Vdc, VGS		IDSS	15	90599	mAdc
Gate-Source Forward Voltage (I _{G(f)} = 1.0 mAdc, V _{DS} = 0)		V _{GS(f)}	-	1.0	Vdc
Drain-Source On-Voltage (I _D = 7.0 mAdc, V _{GS} = 0)		V _{DS} (on)	104	1.5	Vdc
Static Drain-Source On Resistance (I _D = 0.1 mAdc, V _{GS} = 0)		rDS(on)	10.3	150	Ohms
SMALL-SIGNAL CHARA	ACTERISTICS	10 = 0.75 (nee 1)			
Small-Signal Drain-Sour (V _{GS} = 0, I _D = 0, f =		rds(on)		150	Ohms
Input Capacitance (V _{DS} = 15 Vdc, V _{GS}	= 0, f = 1.0 MHz)	C _{iss}	1.0—	5.0	pF
Reverse Transfer Capacitance (V _{DS} = 0, V _{GS} = 10 Vdc, f = 1.0 MHz)		C _{rss}	-	1.2	pF
SWITCHING CHARACTI	ERISTICS				Onr
Turn-On Delay Time	$(V_{DD} = 10 \text{ Vdc}, I_{D(on)} = 7.0 \text{ mAdc},$	t _d (on)	-	5.0	ns
Rise Time	$V_{GS(on)} = 0$, $V_{GS(off)} = -10 \text{ Vdc}$ (See Figure 1)	t _r		5.0	ns
Turn-Off Delay Time	(V _{DD} = 10 Vdc, I _{D(on)} = 7.0 mAdc,	td(off)	-	15	ns
Fall Time	V _{GS(on)} = 0, V _{GS(off)} = -10 Vdc) (See Figure 1)	tf		10	ns

^{*}Pulse Test: Pulse Width < 300 μ s, Duty Cycle < 3.0%.

FIGURE 1 — SWITCHING TIMES TEST CIRCUIT



Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	30	Vdc
Drain-Gate Voltage	V _{DG}	30	Vdc
Reverse Gate-Source Voltage	VGSR	30	Vdc
Forward Gate Current	IGF	10	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Junction Temperature Range	TJ	-65 to +150	°C
Storage Temperature Range	T _{stg}	-65 to +150	°C



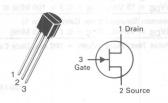
Refer to MPF4391 for graphs.

	Characteristic	Symbol	Min	Max	Unit	
OFF CHARACTERISTI	CS					
Gate-Source Breakdo (I _G = 10 μAdc, V _D			V _(BR) GSS	30	-	Vdc
Gate Reverse Current $(V_{GS} = -15 \text{ Vdc}, V_{GS} = -15 Vdc$			IGSS	-	1.0 1.0	nAdc μAdc
Drain Cutoff Current (VDS = 15 Vdc, VGS = -6.0 Vdc) (VDS = 15 Vdc, VGS = -6.0 Vdc, TA = 100°C)			ID(off)	-	1.0 1.0	nAdc μAdc
ON CHARACTERISTIC	CS					
	Zero-Gate-Voltage Drain Current(1) (V _{DS} = 20 Vdc, V _{GS} = 0)		IDSS	5.0	-	mAdo
	Prain-Source On-Voltage (I _D = 3.0 mAdc, V _{GS} = 0)		V _{DS(on)}	-	0.5	Vdc
Static Drain-Source On Resistance (ID = 1.0 mAdc, VGS = 0)		rDS(on)	-	100	Ohms	
SMALL-SIGNAL CHA	RACTERISTICS				15 10 1	
Static Drain-Source " (VGS = 0, ID = 0,			rds(on)	_	100	Ohms
Input Capacitance (V _{DS} = 0, V _{GS} =	-12 Vdc, f = 1.0 MHz)		C _{iss}	-	10	pF
Reverse Transfer Capacitance (V _{DS} = 0, V _{GS} = -12 Vdc, f = 1.0 MHz)			C _{rss}	-	4.0	pF
SWITCHING CHARAC	CTERISTICS					
Turn-On Delay Time	V _{DD} = 10 Vdc, V _{GS} (on) = 0,	$I_{D(on)} = 3.0 \text{ mAdc}$	t _d (on)	-	8.0	ns
Rise Time		$I_{D(on)} = 3.0 \text{ mAdc}$	tr	-	10	ns
Turn-Off Delay Time	$V_{GS(off)} = -10 \text{ Vdc},$	$I_{D(on)} = 3.0 \text{ mAdc}$	t _d (off)	-	15	ns
Fall Time	RG' = 50 ohms	$I_{D(on)} = 3.0 \text{ mAdc}$	tf	-	30	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 3.0%.

2N5668 thru 2N5670

CASE 29-04, STYLE 5 TO-92 (TO-226AA)



JFET VHF AMPLIFIERS

N-CHANNEL — DEPLETION

Refer to 2N5484 for graphs.

MAXIMUM RATINGS

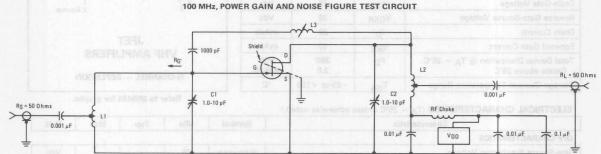
Rating	Symbol	Value	Unit	
Drain-Source Voltage	V _{DS}	25	Vdc	
Drain-Gate Voltage	V _{DG}	25	Vdc	
Reverse Gate-Source Voltage	VGSR	25	Vdc	
Drain Current	ID	20	mAdc	
Forward Gate Current	IG(f)	10	mAdc	
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C	
Storage Channel Temperature Range	T _{stg}	-65 to +150	°C	

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage (I _G = 10 μAdc, V _{DS} = 0)		V(BR)GSS	25	ngagā temut 764	t Strume Tab	Vdc
Gate Reverse Current $(V_{GS} = -15 \text{ Vdc}, V_{DS} = 0)$ $(V_{GS} = -15 \text{ Vdc}, V_{DS} = 0, T_{A} = 100^{\circ}\text{C})$		IGSS	70 F. S 10 10 F. S 10 10 F 10 10 F 10 10 F 10	eg of major West Small control Da - sagged — cell 12 seminal behavior	2.0 2.0	nAdc μAdc
Gate Source Cutoff Voltage $(V_{DS} = 15 \text{ Vdc}, I_D = 10 \text{ nAdc})$	2N5668 2N5669 2N5670	VGS(off)	-0.2 -1.0 -2.0	=	-4.0 -6.0 -8.0	Vdc
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current(1) $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0)$	2N5668 2N5669 2N5670	IDSS	1.0 4.0 8.0	=	5.0 10 20	mAdc
SMALL-SIGNAL CHARACTERISTICS						
Forward Transfer Admittance $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 1.0 \text{ kHz})$	2N5668 2N5669 2N5670	Yfs	1500 2000 3000	=	6500 6500 7500	μmhos
Input Admittance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 100 MHz)		Re(yis)	_	125	800	μmhos
Output Admittance $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 1.0 \text{ kHz})$	2N5668 2N5669 2N5670	Yos		Ξ	20 50 75	μmhos
Output Conductance $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 100 \text{ MHz})$	2N5668 2N5669 2N5670	Re(yos)	=	10 25 35	50 100 150	μmhos
Forward Transconductance $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 100 \text{ MHz})$	2N5668 2N5669 2N5670	Re(yfs)	1000 1600 2500	Ξ	_	μmhos
Input Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)	15	C _{iss}	_	4.7	7.0	pF
Reverse Transfer Capacitance (Vps = 15 Vdc, Vgs = 0, f = 1.0 MHz)		C _{rss}	_	1.0	3.0	pF

2N5668 thru 2N5670

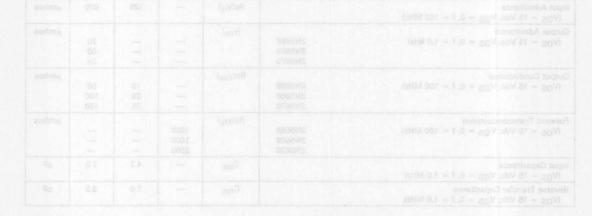
Characteristic	Symbol	Min	Тур	Max	Unit
Output Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)	C _{oss}	=-	1.4	4.0	pF
FUNCTIONAL CHARACTERISTICS				MELSES	
Noise Figure (Figure 1) $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 100 \text{ MHz at } R_{G}' = 1.0 \text{ k ohm})$	NF	-	-	2.5	dB
Common Source Power Gain (Figure 1) (V _{DS} = 15 Vdc, V _{GS} = 0, f = 100 MHz)	G _{ps}	16	-	-	dB

⁽¹⁾ Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.



L1 ≈ 8.5 Turns of #14 AWG Tinned Copper; Dia. ≈ 3/8", ≈ 0.9" Long.
Tapped at ≈ 2-1/2 Turns (adjust to give Rig = 1.0 k ohm);
Parallel Resistance ≈ 40 k ohms; turns at ≈ 8.0 pc.
L2 ≈ 13.5 Turns #16 AWG Tinned Copper; Dia. ≈ 3/8", ≈ 1.2" Long.
Tapped at ~ 5 Turns; Parallel Resistance = 40 k ohms;
tunes at ~ 4.0 pf.

L3 ≈ 17 Turns of #28 AWG Enameled Copper Wire, Close Wound on 9/32" Ceramic Form, Tuning Provided by a Powdered Iron Slug.



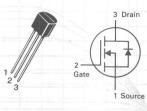
Rating	Symbol	Value	Unit
Drain Source Voltage	V _{DSS}	60	Vdc
Drain-Gate Voltage $(R_{GS} = 1 M\Omega)$	VDGR	60	Vdc
Gate-Source Voltage — Continuous — Non-repetitive (t _p ≤ 50 μs)	V _{GS} V _{GSM}	± 20 ± 40	Vdc Vpk
Drain Current Continuous Pulsed	I _D	200 500	mAdc
Total Power Dissipation @ T _C = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Operating and Storage Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Ambient	RθJA	312.5	°C/W
Maximum Lead Temperature for	TL	300	°C
Soldering Purposes, 1/16" from case			
for 10 seconds	-		

2N7000*

CASE 29-04, STYLE 22 TO-92 (TO-226AA)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage (VGS = 0, ID = 10 μ A)	V(BR)DSS	60		Vdc
Zero Gate Voltage Drain Current $(V_{DS} = 48 \text{ V, } V_{GS} = 0)$ $(V_{DS} = 48 \text{ V, } V_{GS} = 0, T_J = 125^{\circ}\text{C})$	IDSS		1.0 1.0	μAdd mA
Gate-Body Leakage Current, Forward (VGSF = 15 Vdc, VDS = 0)	IGSSF	<u> </u>	-10	nAdd
ON CHARACTERISTICS*	[27]			
Gate Threshold Voltage (V _{DS} = V _{GS} , I _D = 1.0 mA)	VGS(th)	0.8	3.0	Vdc
			+	

VGS(th)	0.8	3.0	Vdc
rDS(on)	_	5.0 6.0	Ohm
V _{DS(on)}	_	2.5 0.45	Vdc
l _{d(on)}	75	_	mA
9fs	100	_	μmhos
	VGS(th) PDS(on) VDS(on)	VGS(th) 0.8 rDS(on) — VDS(on) — Id(on) 75	VGS(th) 0.8 3.0 rDS(on) — 5.0 — 6.0 VDS(on) — 2.5 — 0.45 Id(on) 75 —

DYNAMIC CHARACTERISTICS

		60	pF
Coss	_	25	
C _{rss}	_	5.0	

Turn-On Delay Time	$(V_{DD} = 15 \text{ V}, I_{D} = 500 \text{ mA}$	ton	_	10	ns
Turn-Off Delay Time	$R_{gen} = 25 \text{ ohms}, R_{L} = 25 \text{ ohms})$	toff	_	10	

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μs , Duty Cycle \leq 2.0%.

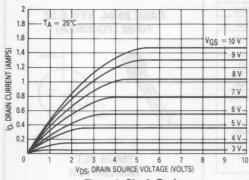


Figure 1. Ohmic Region

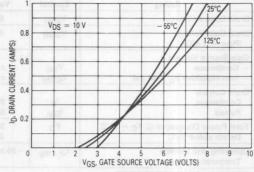


Figure 2. Transfer Characteristics

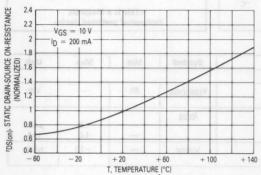


Figure 3. Temperature versus Static Drain-Source On-Resistance

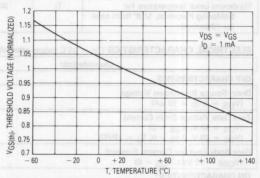
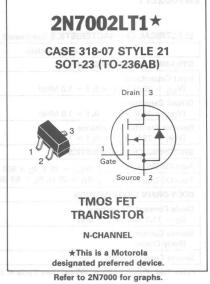


Figure 4. Temperature versus Gate Threshold Voltage

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DSS}	60	Vdc
Drain-Gate Voltage (RGS = 1 M Ω)	VDGR	60	Vdc
Drain Current - Continuous TC = 25°C(1) TC = 100°C(1) - Pulsed (2)	ID ID	± 115 ± 75 ± 800	mA
Gate-Source Voltage — Continuous — Non-repetitive (tp ≤50 μs)	V _{GS} V _{GSM}	± 20 ± 40	Vdc Vpk
Total Power Dissipation $T_C = 25^{\circ}C$ $T_C = 100^{\circ}C$ Derate above 25°C ambient	PD	200 80 1.6	mW mW/°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	625	°C/W
Total Device Dissipation Alumina Substrate,**T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C



*FR-5 = $1.0 \times 0.75 \times 0.062$ in. **Alumina = $0.4 \times 0.3 \times 0.025$ in 99.5% alumina. **DEVICE MARKING**

2N7002LT1 = 702

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage $(V_{GS} = 0, I_D = 10 \mu A)$	V(BR)DSS	60	_	_	Vdc
Zero Gate Voltage Drain Current (VGS = 0, VDS = 60 V) $T_J = 25^{\circ}C$ $T_J = 125^{\circ}C$	I _{DSS}	=	=	1.0 500	μAdc
Gate-Body Leakage Current Forward (VGS = 20 Vdc)	IGSSF	_	_	100	nAdc
Gate-Body Leakage Current Reverse (VGS = -20 Vdc)	IGSSR	_	-	-100	nAdc

⁽¹⁾ The Power Dissipation of the package may result in a lower continuous drain current.

(2) Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

ON CHARACTERISTICS*

Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 250 \mu A$)	V _{GS(th)}	1.0	_	2.5	Vdc
On-State Drain Current $(VDS \ge 2.0 VDS(on), VGS = 10 V)$	I _{D(on)}	500	_	_	mA
Static Drain-Source On-State Voltage ($V_{GS} = 10 \text{ V}, I_D = 500 \text{ mA}$) ($V_{GS} = 5.0 \text{ V}, I_D = 50 \text{ mA}$)	V _{DS(on)}	_	_	3.75 .375	Vdc
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	rDS(on)	=		7.5 13.5 7.5 13.5	Ohms
Forward Transconductance ($V_{DS} \ge 2.0 V_{DS(on)}$, $I_D = 200 \text{ mA}$)	9FS	80	_	_	mmhos

Characteristic			Symbol	Min	Тур	Max	Unit
DYNAMIC CHARACTER	RISTICS		92 T III		2850111	OT MOUNT	Inoû -
Input Capacitance (V _{DS} = 25 V, V _{GS} =	0, f = 1.0 MHz)		C _{iss}	-	100 (1)	50	pF
Output Capacitance (V _{DS} = 25 V, V _{GS} = 0, f = 1.0 MHz)		abV	Coss			25	pF
Reverse Transfer Capacitance (V _{DS} = 25 V, V _{GS} = 0, f = 1.0 MHz)		Wm.	C _{rss}	2	n = 36 = 26	5.0	pF
SWITCHING CHARACT	ERISTICS*	Nilskins	08	26	01 = 31	O St. numelo	summing.
Turn-On Delay Time	(V _{DD} = 25 V, I _D ≅ 500 mA,		t _{d(on)}	_	ana Taman	30	ns
Turn-Off Delay Time	$R_G = 25 \Omega, R_L = 50 \Omega$		td(off)			40	ns
BODY-DRAIN DIODE RA	ATINGS	1000	0.60				
Diode Forward On-Volt (I _S = 11.5 mA, V _{GS}		2PWm1	V _{SD}	_	-	-1.5	V
Source Current Continuous (Body Diode)		With	IS ALL	- Josidon	A of molione	-115	mA
Source Current Pulsed			Ism	- 3/85	= ATT slat	-800	mA

^{*}Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.



Rating	Symbol	Value	Unit	
Drain-Source Voltage	VDS	30 ±30	S Vdc	
Drain-Gate Voltage	VDG	abV 30	Vdc	
Gate-Source Voltage	VGS	30 30	Vdc	
Drain Current	ID	100	mAdc	
Forward Gate Current	lG(f)	sbAm 10	mAdc	
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C	
Storage Channel Temperature Range	T _{stg}	-65 to +150	ol coC	

BF244A,B

CASE 29-04, STYLE 22 TO-92 (TO-226AA)



BF245,A,B,C

CASE 29-04, STYLE 23 TO-92 (TO-226AA)





JFET VHF/UHF AMPLIFIERS

N-CHANNEL - DEPLETION Refer to 2N5484 for graphs.

FLECTRICAL CHARACTERISTICS (TA = 25°C upless otherwise noted)

Characteristic May 6			Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					rrics	RI. TET OAF	OFF CHAI
Gate-Source Breakdown Voltage (IG = 1.0 µAdc, VDS = 0)	Sea(BR)GSS		V _(BR) GSS	30	own Volta O)	0.1 sin 8 ee1 - ≥ <u>e11</u> As	GSV-SOL
Gate-Source (V _{DS} = 15 Vdc, I _D = 200 μA)	BF245A, BF245B,	BF244(2) BF244A BF244B	VGS	0.4 0.4 1.6	200 <u>+</u> A) Volt eg e	7.5 2.2 3.8	
Gate-Source Cutoff Voltage (VDS = 15 Vdc, ID = 10 nA)	BF245C		VGS(off)	3.2 -0.5	(m 01	7.5 ar	CaV Cuto
Gate Reverse Current (VGS = 20 Vdc, VDS = 0)			IGSS		rics	ACTERIS 5	AHNAIO
ON CHARACTERISTICS	660		SF246A		[0] =	SEIV VI at	e savi
Zero-Gate Voltage Drain Current (VDS = 15 Vdc, VGS = 0)	BF245(1), BF245A, BF245B, BF245C	BF244(2) BF244A BF244B	IDSS	2 2 6 12	IARACTER Invitance 10 mA. I	25 6.5 15 25	Am SMALL-E Forward I (Vos.=
SMALL-SIGNAL CHARACTERISTICS	E ₁₈ g				esmenseq	ransfer	Reverse
Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1 KHz)	n _i O		Yfs	3.0		6.5	mmhos
Output Admittance (VDS = 15 Vdc, VGS = 0, f = 1 KHz)	nie0		Yos		40	er a salonqu	μmhos
Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 200 MHz)			Y _{fs}	Tarrest 1	5.6	v i oup	mmhos
Reverse Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 200 MHz)			Y _{rs}		1.0	25	mmhos
Input Capacitance (Vps = 20 Vdc, -Vgs = 1 Vdc)			Ciss		3		pF
Reverse Transfer Capacitance (VDS = 20 Vdc, - VGS = 1 Vdc, f = 1 MHz)			C _{rss}		0.7		pF
Output Capacitance (VDS = 20 Vdc, -VGS = 1 Vdc, f = 1 MHz)			Coss		0.9		pF
Noise Figure (VDS = 15 Vdc, VGS = 0, RG = 1 K Ω , f = 100 MHz)			NF		1.5		db
Cut-off Frequency(3) (VDS = 15 Vdc, VGS = 0)			F(Yfs)		700		MHz

⁽¹⁾ On orders against the BF245, any or all subgroups might be shipped. (2) On orders against the BF244, any or all subgroups might be shipped. (3) The frequency at which gfs is 0.7 of its value at 1 KHz.

CASE 29-04, STYLE 22 OFF CASE 29-04, STYLE 22 OFF CASE 29-04, STYLE 23 OFF CASE 29-04, STYLE 23

MAXIMUM RATINGS

Rating	Symbol	Value	Unit	
Drain-Source Voltage	VDS	56V ± 25	Vdc	
Drain-Gate Voltage	VDG	abV 25	Vdc	
Gate-Source Voltage	VGS	abV 25	Vdc	
Drain Current	ID	100	mAdc	
Forward Gate Current	lG(f)	pbAm 10	mAdc	
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C	
Storage Channel Temperature Range	T _{stg}	-65 to +150	°C	

BF246A,B

CASE 29-04, STYLE 22 TO-92 (TO-226AA)



BF247B

CASE 29-04, STYLE 5 TO-92 (TO-226AA)





JFETs SWITCHING

N-CHANNEL - DEPLETION

Refer to MPF4391 for graphs.

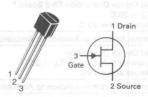
ELECTRICAL	CHARACTERISTICS	ITA = 25°C unless	otherwise noted)

tinti - xel	M GYT C	haracteri	stic		Symbol	Min	Тур	Max	Unit
OFF CHARACT	ERISTICS						rics	SUBTOAR	AND 190
Gate-Source Br (I _G = 1 μA, V _I	reakdown Voltag DS = 0)	ge 08	SZD(RB)V		V(BR)GSS	25	etloV nwo	roe Brauler V co vi to Vi	los Vas
Gate-Source (V _{DS} = 15 V,	I _D = 200 μA)	0.4	BF246A BF246B,	BF247B	VGS	-1.5 -3	Au GOS =	-4 -7	eaV-Soi
Gate-Source Co (VDS = 15 V,		1.6		BR2448	VGS(off)	0.6		14.5	V
Gate Cutoff Cu (VGS = 15 V,		-0.6	VGS(off)		IGSS		Voltage (An-01 =	16/10/801	nA
ON CHARACTI	ERISTICS		lass				li li	rse Currer	Sate Reve
Zero-Gate Volta (VDS = 15 V,	age Drain Curre VGS = 0)	nt	BF246A BF246B,	BF247B	IDSS	30 60	TICS	80 140	mA
SMALL-SIGNA	L CHARACTER	ISTICS		BF244(2)	BF245(1).		(0 = gg	15 Vdc. Vi	= savi
Forward Transf (VDS = 15 V,	er Admittance ID = 10 mA, f =	= 1 kHz)		BF244B	Y _{fs}	8	23		mmhos
Reverse Transfe (VDS = 15 V,	er Capacitance ID = 10 mA, f =	= 1 kHz)			C _{rss}	istics	3.3	io LAliei	pF
Input Capacitar (VDS = 15 V,	nce ID = 10 mA, f =	= 1 MHz)	18171		C _{in}	1 KHz)	6	V Jak Var	pF
Output Capacit (VDS = 15 V,	ance ID = 10 mA, f =	= 1 MHz)	18011		Cout	1 KHz1	5	15 Vac. V	pF
Cutoff Frequen (VDS = 15 V,			18171		F(Yfs)	HIM COS	450	16 Vdc, V	MHz
SUITINI	0.1		Tarti			200 MHz	= 0, f =	Tallister Ad 15 Vdc, Vd	= SUA)

BFR30LT1 BFR31LT1

BF256B,C

CASE 29-04, STYLE 23 TO-92 (TO-226AA)



JFET VHF/UHF AMPLIFIERS

N-CHANNEL - DEPLETION

Refer to 2N5484 for graphs.

MAXIMUM BATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	VDS	±30	Vdc
Drain-Gate Voltage	VDG	30	Vdc
Gate-Source Voltage	VGS	30	Vdc
Drain Current	ID	100	mAdc
Forward Gate Current	IG(f)	10	mAdc
Total Device Dissipation @ TA = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Storage Channel Temperature Range	T _{stg}	-65 to +150	°C

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Chara	acteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	TURTITIES.		Pistito	Participation .			
Gate-Source Breakdown Voltage (IG = 1.0 μAdc, VDS = 0)	8891		V(BR)GSS	30	_	script sen	Vdc
Gate-Source Voltage (VDS = 15 Vdc, ID = 200 μ A)			VGS(off)	-0.5	oltane	-7.5	Vdc
Gate Reverse Current (VGS = 20 Vdc, VDS = 0)		DER19	IGSS	_	90 V 0 <u>11</u> = 20	5	nAdc
ON CHARACTERISTICS	Ves	a market and				epatioV so	Gate Sour
Zero-Gate Voltage Drain Current) (VDS = 15 Vdc, VGS = 0)		256B 256C	IDSS	6 11		13 18	mAdc
SMALL-SIGNAL CHARACTERIST	ICS	TERRE					-
Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1 k	Hz)		Yfs	4.5	5 80	T. IFET DAY	mmhos
Reverse Transfer Capacitance (VDS = 20 Vdc, -VGS = 1Vdc, f	= 1 MHz)	OERRSO REPORT	C _{rss}	_	0.7	10 Ves vi	pF
Output Capacitance (VDS = 20 Vdc, VGS = 0, f = 1 M	ЛНz)		Coss		1.0	eo Takas	pF
Noise Figure (VDS = 10 Vdc, $R_S = 47\Omega$, $f = 80$	00 MHz)	OCATIB.	NF	0,1 = 1,0	7.5	A ph.Am D.	db
Cut-off Frequency(2) (VDS = 15 Vdc, VGS = 0)		ORRER	fgfs		1000		MHz
Power Gain (VDS = 15 Vdc, $R_S = 47 \Omega$, $f = 80$	OO MHz)	BPR31	Gp	_	11		dB

(1) The frequency at which gfs is 0.7 of its value at 1 kHz.

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	25	Vdc
Gate-Source Voltage	VGS	25	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		obV 2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{stg}	-55 to +150	°C

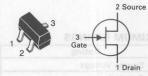
^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BFR30LT1 = M1; BFR31LT1 = M2

BFR30LT1 BFR31LT1

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)



JFET AMPLIFIERS

N-CHANNEL

Refer to 2N5457 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS			to a state of	Carrier Carrier	124170 234
Gate Reverse Current (VGS = 10 Vdc, VDS = 0)		IGSS	<u>-(0 =</u>	0.2	nAdc
Gate Source Cutoff Voltage (ID = 0.5 nAdc, VDS = 10 Vdc)	BFR30 BFR31	VGS(off)	260 µA) = 07	5.0 2.5	Vdc
Gate Source Voltage (I _D = 1.0 mAdc, V _{DS} = 10 Vdc) (I _D = 50 μAdc, V _{DS} = 10 Vdc)	BFR30 BFR31 BFR30 BFR31	V _G S	-0.7 -0.7 -0.9	-3.0 -1.3 -4.0 -2.0	SOA)
ON CHARACTERISTICS			sangti	mbA relans	il briswrio
Zero-Gate-Voltage Drain Current (V _{DS} = 10 Vdc, V _{GS} = 0)	BFR30 BFR31	IDSS	4.0 1.0	10 5.0	mAdc
SMALL-SIGNAL CHARACTERISTICS		1-146	1-1-5-	90087000	a) togiat
Forward Transconductance (I _D = 1.0 mAdc, V _{DS} = 10 Vdc, f = 1.0 kHz)	BFR30 BFR31	Y _{fs}	1.0	4.0 4.5	mAdc
$(I_D = 200 \ \mu Adc, V_{DS} = 10 \ Vdc, f = 1.0 \ kHz)$	BFR30 BFR31		0.5 0.75	agueroy(2) 15 V <u>dc</u> Vgs	Lut-off Eu (Vps = Power Ga
Output Admittance (ID = 1.0 mAdc, V_{DS} = 10 Vdc, f = 1.0 kHz) (ID = 200 μ Adc, V_{DS} = 10 Vdc)	BFR31 BFR31	Yosl	40 20	25 15	μAdc
Input Capacitance (ID = 1.0 mAdc, V_{DS} = 10 Vdc, f = 1.0 MHz) (ID = 200 μ Adc, V_{DS} = 10 Vdc, f = 1.0 MHz)		C _{iss}	=	5.0 4.0	pF
Reverse Transfer Capacitance (I _D = 1.0 mAdc, V _{DS} = 10 Vdc, f = 1.0 MHz) (I _D = 200 µAdc, V _{DS} = 10 Vdc, f = 1.0 MHz)		C _{rss}	= =	1.5 1.5	pF

Note: "LT1" must be used when ordering SOT-23 devices.

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

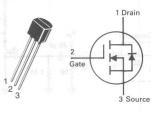
Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	200	Vdc
Gate-Source Voltage — Continuous — Non-repetitive (tp ≤ 50 μs)	V _G S V _G SM	±20 ±30	Vdc Vpk
Drain Current Continuous(1) Pulsed(2)	I _D	250 500	mAdd
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350	mW
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to 150	°C

(1) The Power Dissipation of the package may result in a lower continuous drain current.

(2) Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

BS107,A*

CASE 29-04, STYLE 30 TO-92 (TO-226AA)



TMOS SWITCHING

N-CHANNEL — ENHANCEMENT

★BS107A is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS				-	0.0
Zero-Gate-Voltage Drain Current (V _{DS} = 130 V, V _{GS} = 0)	IDSS		V či	30	nAdc
Drain-Source Breakdown Voltage (V _{GS} = 0, I _D = 100 μA)	V(BR)DSX	200	+	_	Vdc
Gate Reverse Current (VGS = 15 Vdc, VDS = 0)	IGSS		0.01	10	nAdc
ON CHARACTERISTICS*					-
Gate Threshold Voltage (Ip = 1.0 mA, Vps = Vgs)	VGS(Th)	1.0		3.0	Vdc
Static Drain-Source On Resistance BS107 (VGS = 2.6 V, I _D = 20 mA) (VGS = 10 V, I _D = 200 mA) BS107A (VGS = 10 Vdc)	rDS(on)	E ES	es es UNCTYON VEN	28 14	Ohms
(I _D = 100 mA) (I _D = 250 mA)		_	4.5 4.8	6.0 6.4	
SMALL-SIGNAL CHARACTERISTICS					
Input Capacitance (Vps = 25 V, Vgs = 0, f = 1.0 MHz)	C _{iss}	_	60	1—1	pF
Reverse Transfer Capacitance ($V_{DS} = 25 \text{ V, } V_{GS} = 0, f = 1.0 \text{ MHz}$)	C _{rss}	ER CHARAC	6.0	I I TOPH	pF
Output Capacitance (V _{DS} = 25 V, V _{GS} = 0, f = 1.0 MHz)	C _{oss}	-\	30		pF
Forward Transconductance (V _{DS} = 25 V, I _D = 250 mA)	9fs	200	400	= 80 <u>4</u>	mmhos
SWITCHING CHARACTERISTICS					18.0 5
Turn-On Time	ton		6.0	15	ns
Turn-Off Time	toff	_	12	15	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

RESISTIVE SWITCHING

FIGURE 1 — SWITCHING TEST CIRCUIT

FIGURE 2 — SWITCHING WAVEFORMS

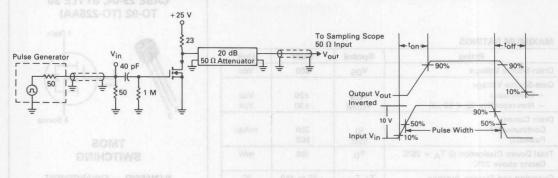


FIGURE 3 — ON VOLTAGE versus TEMPERATURE

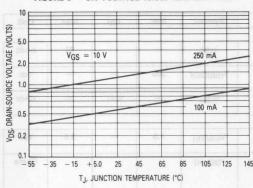


FIGURE 4 — CAPACITANCE VARIATION

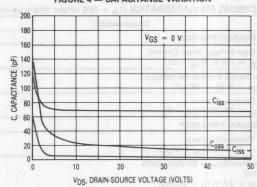


FIGURE 5 — TRANSFER CHARACTERISTIC

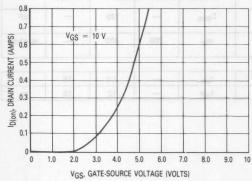
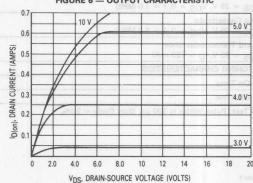
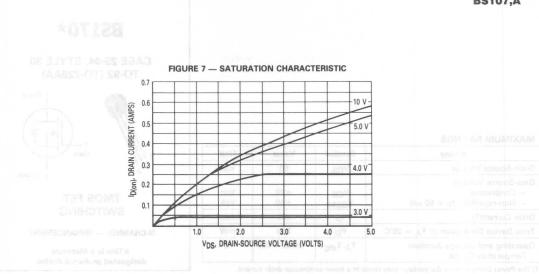


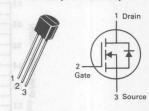
FIGURE 6 — OUTPUT CHARACTERISTIC





BS170*

CASE 29-04, STYLE 30 TO-92 (TO-226AA)



TMOS FET SWITCHING

N-CHANNEL — ENHANCEMENT

★This is a Motorola designated preferred device.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	60	Vdc
Gate-Source Voltage — Continuous — Non-repetitive (tp ≤ 50 μs)	V _{GS}	± 20 ± 40	Vdc Vpk
Drain Current(1)	ID	0.5	Adc
Total Device Dissipation @ T _A = 25°C	PD	350	mW
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C

(1) The Power Dissipation of the package may result in a lower continuous drain current.

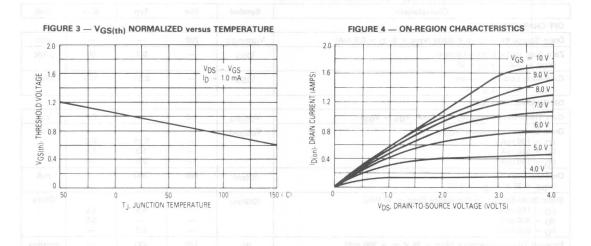
ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

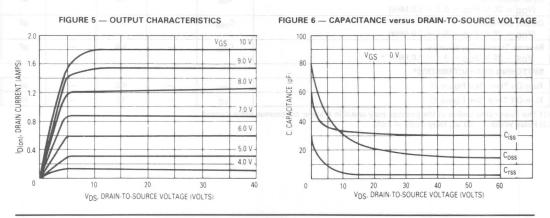
Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Gate Reverse Current (VGS = 15 V, VDS = 0)	IGSS		0.01	10	nAdc
Drain-Source Breakdown Voltage (VGS = 0, ID = 100 μ A)	V(BR)DSS	60	90	-	Vdc
ON CHARACTERISTICS(2)					
Gate Threshold Voltage (V _{DS} = V _{GS} , I _D = 1.0 mA)	VGS(Th)	0.8	2.0	3.0	Vdc
Static Drain-Source On Resistance (VGS = 10 V, I _D = 200 mA)	rDS(on)	-	1.8	5.0	Ohms
Drain Cutoff Current (V _{DS} = 25 V, V _{GS} = 0 V)	^I D(off)		-	0.5	μΑ
Forward Transconductance (V _{DS} = 10 V, I _D = 250 mA)	9fs	1-	200	-	mmhos
SMALL-SIGNAL CHARACTERISTICS					
Input Capacitance $(V_{DS} = 10 \text{ V}, V_{GS} = 0, f = 1.0 \text{ MHz})$	C _{iss}		-	60	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (I _D = 0.2 A) See Figure 1	ton	-	4.0	10	ns
Turn-Off Time (I _D = 0.2 A) See Figure 1	toff	-	4.0	10	ns

(2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

RESISTIVE SWITCHING

FIGURE 2 — SWITCHING WAVEFORMS FIGURE 1 — SWITCHING TEST CIRCUIT + 25 V **§** 125 Ω To Sampling Scope 50 Ω Input 20 dB Pulse Generator → V_{out} 50 Ω Attenuator 50 Ω 90% **§** 1.0 MΩ 10% **§** 50 Ω Output |Vout 10% (Vin Amplitude 10 Volts) Input Vin Pulse Width

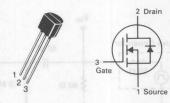




Rating	Symbol	Value	Unit
Drain-Source Voltage	VDSS	200	Vdc
Gate-Source Voltage — Continuous — Non-repetitive (tp ≤ 50 μs)	V _{GS} V _{GSM}	± 20 ± 40	Vdc Vpk
Drain Current — Continuous (1) — Pulsed (2)	I _D	400 800	mAdc
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Operating and Storage Temperature Range	T _J , T _{stg}	-55 to +150	°C
Thermal Resistance Junction to Ambient	θ JA	208	°C/W

BSS89

CASE 29-04, STYLE 7 TO-92 (TO-226AA)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

Refer to BS107 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	BRUTAFARMS	Tauries CE	SLIAMBOW (a	manV — 83	BUDIS
Drain-Source Breakdown Voltage (V _{GS} = 0, I _D = 0.5 mA)	V(BR)DSS	200	_	_	Vdc
Zero Gate Voltage Drain Current (Vps = 200 V, Vgs = 0)	IDSS	any	0.1	60	μAdc
Gate-Body Leakage Current (VGS = 20 V, VDS = 0)	IGSS		0.01	100	nAdc
ON CHARACTERISTICS*					- 11 5
Gate Threshold Voltage (I _D = 1.0 mA, V _{DS} = V _{GS})	V _{GS(th)}	1.0		2.7	Vdc
Drain-Source On-Voltage (V _{GS} = 10 V) (I _D = 100 mA) (I _D = 300 mA) (I _D = 500 mA)	VDS(on)	E	0.45 1.2 3.0	0.6 1.8	Vdc
On-State Drain Current (Vps = 25 V, V _{GS} = 10 V)	I _{D(on)}	500	700		mA
Static Drain-Source On-Resistance (VGS = 10 Vdc) (ID = 150 mA) (ID = 300 mA) (ID = 500 mA)	rDS(on)	amu <u>a</u> ndawi	4.5 — 6.0	6.0 6.0	Ohms
Forward Transconductance (V _{DS} = 25 V, I _D = 300 mA)	9fs	140	400	_	mmhos
DYNAMIC CHARACTERISTICS		WHITE I		WITH THE	THE REAL PROPERTY.
Input Capacitance (Vps = 25 V, Vgs = 0, f = 1.0 MHz)	C _{iss}	-	72	-	pF
Output Capacitance (Vps = 25 V, V _{GS} = 0, f = 1.0 MHz)	Coss	PST-2ARAH	15	R <u>CU</u> RE 5	pF
Reverse Transfer Capacitance (V _{DS} = 25 V, V _{GS} = 0, f = 1.0 MHz)	C _{rss}	<u> </u>	2.8	_	pF
SWITCHING CHARACTERISTICS*	The Land of the Land				1 8
Turn-On Time (See Figure 1)	ton	_	6.0	-	ns
Turn-Off Time (See Figure 1)	toff		12	-//	ns

⁽¹⁾ The Power Dissipation of the package may result in a lower continuous drain current.

(2) Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DSS}	100	Vdc
Gate-Source Voltage — Continuous — Non-repetitive (t _p ≤ 50 μs)	V _{GS}	± 20 ± 40	Vdc Vpk
Drain Current Continuous (1) Pulsed (2)	I _D	0.17 0.68	Adc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_{\hbox{$\mbox{Λ}}} = 25^{\circ}\hbox{$\mbox{$C$}}$ Derate above 25°C	PD T	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

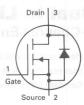
DEVICE MARKING

BSS123LT1 = SA

BSS123LT1*

CASE 318-07, STYLE 21 SOT-23 (TO-236AB)





TMOS FET TRANSISTOR

N-CHANNEL

★This is a Motorola designated preferred device.

Refer to 2N7000 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	Symbol		gribari			
Drain-Source Breakdown Voltage (VGS = 0, ID = 250 μA)	eadA	V(BR)DSS	100	-	oure = loruo	Vdc
Zero Gate Voltage Drain Current $(V_{GS} = 0, V_{DS} = 100 \text{ V})$ $T_J = 25^{\circ}\text{C}$ $T_J = 125^{\circ}\text{C}$	HEOV SEV	IDSS	_	Ξ	15 60	μAdc
Gate-Body Leakage Current (V _{GS} = 20 Vdc, V _{DS} = 0)	Ql MOI	IGSS	- oral	= D Enoral	50	nAdc
ON CHARACTERISTICS*	-0		170	30 - a1 60 an	Here Victoria	out tellar
Gate Threshold Voltage (V _{DS} = V _{GS} , I _D = 1.0 mA)	10	V _{GS(th)}	0.8	-	2.8	Vdc
Static Drain-Source On-Resistance (VGS = 10 Vdc, I _D = 100 mA)	Dist. C.	rDS(on)	PARTON A	5.0	6.0	Ohms
Forward Transconductance (V _{DS} = 25 V, I _D = 100 mA)	ALIPR	9fs	80	of no ley nut.	Fear	mmhos
DYNAMIC CHARACTERISTICS						
Input Capacitance $(V_{DS} = 25 \text{ V}, V_{GS} = 0, f = 1.0 \text{ MHz})$		C _{iss}	-	20	_	pF
Output Capacitance (V _{DS} = 25 V, V _{GS} = 0, f = 1.0 MHz)		C _{oss}	_	9.0	_	pF
Reverse Transfer Capacitance (V _{DS} = 25 V, V _{GS} = 0, f = 1.0 MHz)		C _{rss}	_	4.0	_	pF
SWITCHING CHARACTERISTICS*						
Turn-On Delay Time $(V_{CC} = 30 \text{ V, } I_{C} = 0)$	0.28 A,	t _{d(on)}	_	20	_	ns
Turn-Off Delay Time VGS = 10 V, RGS =	= 50 Ω)	td(off)	_	40	_	ns
REVERSE DIODE						
Diode Forward On-Voltage (I _D = 0.34 A, V _{GS} = 0 V)		V _{SD}	-	-	1.3	V

⁽¹⁾ The Power Dissipation of the package may result in a lower continuous drain current.

⁽²⁾ Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. *Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

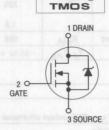
TMOS Field Effect Transistor Dual In-Line Package

N-Channel Enhancement Mode

- Ideal for Peripheral Control Applications
- Intermediate 1 Watt Power Capability
- Standard DIP Outline

IRFD110 IRFD113

> TMOS FET TRANSISTORS FET DIP





CASE 370-01, STYLE 1

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	IRFD110	IRFD113	Unit
Drain-Source Voltage	V _{DSS}	100	60	Vdc
Drain-Gate Voltage (R _{GS} = 20 kΩ)	VDGR	100	60	Vdc
Gate-Source Voltage	V _{GS}	3 dS1 = ±20		Vdc
Drain Current — Continuous T _C = 25°C — Pulsed	I _D	1.0 8.0	0.8 6.4	Adc
Total Power Dissipation @ T _C = 25°C Derate above 25°C	PD		1.0	Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{stg}	-55 t	to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient	R ₀ JA	120	°C/W
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ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characte	Characteristic		Min	Тур	Max	Unit
OFF CHARACTERISTICS	ar on these	announced to 4	Jan. 19. 19.	ca		1.75 8.40
Drain-Source Breakdown Voltage (V _{GS} = 0, I _D = 250 μA)	IRFD110 IRFD113	V _{(BR)DSS}	100 60	a pro		Vdc
Zero Gate Voltage Drain Current (VDS	S = Rated V _{DSS} , V _{GS} = 0 V)	IDSS	\$rtsurr	earled	250	μAdc
Gate-Body Leakage Current, Forward (V _{GSF} = 20 V)	IGSSF	_	_	500	nAdc
Gate-Body Leakage Current, Reverse (V _{GSR} = -20 V)	IGSSR	plications	ga lezino 3	-500	nAdc
ON CHARACTERISTICS	一种基础性		papelity	Power Ca	ite I Watt	inemedia
Gate Threshold Voltage (I _D = 250 μA, V _{DS} = V _{GS})		V _{GS(th)}	2.0	_ 0	4.0	Vdc
Static Drain-Source On-Resistance (1) (V _{GS} = 10 Vdc, I _D = 0.8 A)	IRFD110 IRFD113	R _{DS(on)}	_	_	0.6 0.8	Ohms
On-State Drain Current (1) (VGS = 10 V, VDS = 5.0 V)	IRFD110 IRFD113	I _{D(on)}	1.0 0.8	=	_	Adc
Forward Transconductance (1) (I _D = 0.8 A, V _{DS} = 5.0 V)		9FS	0.8	_	-	mhos
CAPACITANCE	1 01					
Input Capacitance		C _{iss}	_	_	200	pF
Output Capacitance	$(V_{DS} = 25 \text{ V}, V_{GS} = 0,$ f = 1.0 MHz)	Coss	1-2	_	100	1
Reverse Transfer Capacitance	1 – 110 mm 12)	C _{rss}	entia <u>za</u> elne	17 - 125°C	25	MUMBCA
SWITCHING CHARACTERISTICS	Flymbol 19		pnlluF			
Turn-On Delay Time	Vioes	^t d(on)		_	20	ns
Rise Time 001	(V _{DS} ≈ 0.5 V _{(BR)DSS} ,	t _r		_	25	/ ersiD-nimG
Turn-Off Delay Time	$I_D = 0.8 \text{ A}, Z_O = 50 \Omega$	^t d(off)		-	25	2 = 89(4)
Fall Time		tf			20	Galle-Sourc
SOURCE-DRAIN DIODE CHARACTER	ISTICS	•	0.6	; 0 L enon	name o e i	Period Marc
Diode Forward Voltage (V _{GS} = 0) I _S I _S	= 1.0 A, IRFD110 = 0.8 A, IRFD113	VF	= 5	8S = <u>5</u> T 6	2.5 2.0	Vdc
Continuous Source Current, Body Dioc	le IRFD110 IRFD113	IS	e <u>pne</u> n	เปล <u>ายว</u> กษา	1.0 0.8	Adc
Pulsed Source Current, Body Diode	IRFD110 IRFD113	ISM	ice ll ámA	os ar izi nal	8.0 6.4	A
Forward Turn-On Time	/I Detect V 2	ton		negligible		ns
Reverse Recovery Time	$(I_S = Rated I_S, V_{GS} = 0)$	t _{rr}	_	100	_	1

^{1.} Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

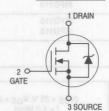
TMOS Field Effect Transistor Dual In-Line Package

N-Channel Enhancement Mode

- Ideal for Peripheral Control Applications
- Intermediate 1 Watt Power Capability
- Standard DIP Outline

IRFD120 IRFD123

TMOS FET TRANSISTORS FET DIP



TMOS



CASE 370-01, STYLE 1

MAXIMUM RATINGS (TA = 25°C unless otherwise noted)

Rating	Symbol	IRFD120	IRFD123	Unit
Drain-Source Voltage	V _{DSS}	100	60	Vdc
Drain-Gate Voltage (RGS = 20 kΩ)	VDGR	100	60	Vdc
Gate-Source Voltage	V _{GS}	±20		Vdc
Drain Current — Continuous T _C = 25°C — Pulsed	ID IDM	1.3 5.2	1.1 4.4	Adc
Total Power Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0 8.0		Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

			U RUCKE AMPRILL T
Thermal Resistance — Junction-to-Ambient	R ₀ JA	120	°C/W

SEMICONDUCTOR TECHNICAL DATA

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characte	eristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	as an electrical	Sales Sales Sales and Publish	A	R151 E-1	Land British	COLUMN BU
Drain-Source Breakdown Voltage (VGS = 0, I _D = 250 μA)	IRFD120 IRFD123	V(BR)DSS	100 60		i.h.n	Vdc
Zero Gate Voltage Drain Current (VDSS	S = Rated V _{DSS} , V _{GS} = 0 V)	IDSS	A Welmer	BOOK THOSE	250	μAdc
Gate-Body Leakage Current, Forward (V _{GSF} = 20 V)	IGSSF	_	-	500	nAdc
Gate-Body Leakage Current, Reverse (V _{GSR} = -20 V)	IGSSR	an -U ma	ggA Jo nno	-500	nAdc
ON CHARACTERISTICS	WANTED TO THE PARTY OF THE PART		vfilids	ower Cap	Hay/	sibermed
Gate Threshold Voltage (I _D = 250 μA, V _{DS} = V _{GS})		VGS(th)	2.0	_	4.0	Vdc
Static Drain-Source On-Resistance (1) $(V_{GS} = 10 \text{ Vdc}, I_D = 0.6 \text{ A})$	IRFD120 IRFD123	R _{DS(on)}	_	=	0.3 0.4	Ohms
On-State Drain Current (1) (VGS = 10 V, VDS = 5.0 V)	IRFD120 IRFD123	I _{D(on)}	1.3 1.1	=	=	Adc
Forward Transconductance (1) (I _D = 0.6 A, V _{DS} = 5.0 V)		9FS	0.9	-	_	mhos
APACITANCE	1 2 1 1 0 8					1
Input Capacitance	3100	C _{iss}	_	_	600	pF
Output Capacitance	$(V_{DS} = 25 \text{ V}, V_{GS} = 0,$ f = 1.0 MHz)	Coss	_	_	400	1
Reverse Transfer Capacitance	1 = 1.0 WHZ	C _{rss}	liage_allner) = <u>28</u> °C u	100	H MUM
WITCHING CHARACTERISTICS	Symbol IRI		priita	\$1		
Turn-On Delay Time	Vpss	td(on)	_	_	40	ns
Rise Time 021	$(V_{DS} \approx 0.5 V_{(BR)DSS},$	t _r	_	_	70	n-Gate 1
Turn-Off Delay Time	$I_D = 0.6 \text{ A}, Z_O = 50 \Omega)$	td(off)			100	02 = 80h
Fall Time		tf	_	_	70	ec1008-5
OURCE-DRAIN DIODE CHARACTERI	STICS		- 0	ÇZ = Ö I. SNO	head -	Herido III
Diode Forward Voltage (V _{GS} = 0) I _S I _S	= 1.3 A, IRFD120 = 1.1 A, IRFD123	VF	=	2 T <u>n =</u> 25°C	2.5 2.3	Vdc
Continuous Source Current, Body Diod	e IRFD120 IRFD123	Is	Rem <u>ea</u>	enutragme	1.3 1.1	Adc
Pulsed Source Current, Body Diode	IRFD120 IRFD123	ISM	meldm	RISTICS Incluintout	5.2 4.4	A
Forward Turn-On Time	(I D-1-11 V 0)	ton		negligible		ns
Reverse Recovery Time	$(I_S = Rated I_S, V_{GS} = 0)$	t _{rr}	_	280	_	1

^{1.} Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

TMOS Field Effect Transistor Dual In-Line Package

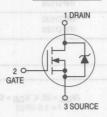
N-Channel Enhancement Mode

- Ideal for Peripheral Control Applications
- Intermediate 1 Watt Power Capability
- Standard DIP Outline

IRFD210 IRFD213



TMOS FET TRANSISTORS FET DIP





CASE 370-01, STYLE 1

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	IRFD210	IRFD213	Unit
Drain-Source Voltage	VDSS	200	150	Vdc
Drain-Gate Voltage (RGS = $20 \text{ k}\Omega$)	VDGR	200	150	Vdc
Gate-Source Voltage	V _{GS}	±20		Vdc
Drain Current — Continuous T _C = 25°C — Pulsed	I _D	0.6 2.5	0.45 1.8	Adc
Total Power Dissipation @ T _C = 25°C Derate above 25°C	PD	1.0 0.008		Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{stg}	-55 to +150		°C

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient	R ₀ JA	120	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characte	Symbol	Min	Тур	Max	Unit	
OFF CHARACTERISTICS	446	La m				
Drain-Source Breakdown Voltage (VGS = 0, I _D = 250 μA)	IRFD210 IRFD213	V(BR)DSS	200 150	b <u>l</u> si	및 HO	Vdc
Zero Gate Voltage Drain Current (VDSS	S = Rated V _{DSS} , V _{GS} = 0 V)	IDSS	13. P.T. A	1.37 (1 m)	250	μAdc
Gate-Body Leakage Current, Forward (V _{GSF} = 20 V)	IGSSF	leme:	ngane	500	nAdc
Gate-Body Leakage Current, Reverse (V _{GSR} = -20 V)	IGSSR	ita-iland	hutani Dilan	-500	nAdo
ON CHARACTERISTICS	2/9/9		diliriams.)	Vall Power	J. T. Hrshai	manni
Gate Threshold Voltage (ID = 250 μ A, VDS = VGS)		V _{GS(th)}	2.0	Brillia	0 4.0 mg	Vdc
Static Drain-Source On-Resistance (1) $(V_{GS} = 10 \text{ Vdc}, I_D = 0.3 \text{ A})$	IRFD210 IRFD213	R _{DS} (on)	_	_	1.5 2.4	Ohms
On-State Drain Current (1) (VGS = 10 V, VDS = 5.0 V)	I _{D(on)}	1.5 2.4	_	_	Adc	
Forward Transconductance (1) (I _D = 0.3 A, V _{DS} = 5.0 V)	9FS	0.5	-	_	mhos	
CAPACITANCE	1 1 1 00					
Input Capacitance	STAG	C _{iss}		_	150	pF
Output Capacitance	$(V_{DS} = 25 \text{ V}, V_{GS} = 0,$ f = 1.0 MHz)	Coss	_	_	80	
Reverse Transfer Capacitance	U08 & T = 1.0 Mil.2)	C _{rss}	sevina 0%	R = ATI BO	25	IMIXAI
SWITCHING CHARACTERISTICS	Indiana?		noticis:			
Turn-On Delay Time	Vnes	t _d (on)	_		15	ns
Rise Time	(VDS ≈ 0.5 V(BB)DSS	t _r			25	Sentime
Turn-Off Delay Time	$I_D = 0.3 \text{ A}, Z_0 = 50 \Omega)$	td(off)	_	_	15	(8(3)
Fall Time		t _f	_	— b _i	15	d-else
SOURCE-DRAIN DIODE CHARACTERI	STICS		2= 25°C	T' supuntma	Ø - namt	Onain C
Diode Forward Voltage (V _{GS} = 0) I _S = 0.6 A, IRFD210 I _S = 0.45 A, IRFD213		VF	-	aT w note	2.0	Vdc
Continuous Source Current, Body Diod	e IRFD210 IRFD213	Is	Stand Tanuals	regment ega	0.6 0.45	Adc
Pulsed Source Current, Body Diode	IRFD210 IRFD213	ISM	_80t	A CT ZBAIS	2.5 1.8	A
Forward Turn-On Time	(In Dated In Man O	ton	300 TA (0)	negligible		ns
Reverse Recovery Time	$(I_S = Rated I_S, V_{GS} = 0)$	t _{rr}	_	290	_	1

^{1.} Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

TMOS Field Effect Transistors Dual In-Line Package

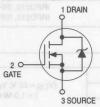
IRFD220 IRFD223

N-Channel Enhancement Mode

- Ideal for Peripheral Control Applications
- Intermediate 1 Watt Power Capability
- Standard DIP Outline



TMOS FET TRANSISTORS FET DIP





CASE 370-01, STYLE 1

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating		Symbol	IRFD220	IRFD223	Unit
Drain-Source Voltage	(n3)bi	VDSS	200	150	Vdc
Drain-Gate Voltage (R _{GS} = 20 kΩ)	$\frac{1}{\sqrt{ B_0 ^2}} = \frac{220(B_0)^{3/2}}{\sqrt{ B_0 ^2}}$	VDGR	200	150	Vdc
Gate-Source Voltage		VGS	±20		Vdc
Drain Current — Continuous T _C = 25°C — Pulsed	av I	I _D	0.8 2.4	0.7 5.6	Adc
Total Power Dissipation @ T _C = 25°C Derate above 25°C	al	PD	1.0		Watts mW/°C
Operating and Storage Temperature Range	DESCRIPTION OF THE	TJ, Tstg	-55 t	o +150	°C

THERMAL CHARACTERISTICS

	2.53.1.53.1		
Thermal Resistance — Junction-to-Ambient	R ₀ JA	120	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Charac	Symbol	Min	Тур	Max	Unit	
FF CHARACTERISTICS						
Drain-Source Breakdown Voltage (V _{GS} = 0, I _D = 250 μA)	IRFD220 IRFD223	V(BR)DSS	200 150	Disi	4 -200 - Tu	Vdc
Zero Gate Voltage Drain Current (VDS	SS = Rated V _{DSS} , V _{GS} = 0 V)	IDSS	M. 1250 III		250	μAdc
Gate-Body Leakage Current, Forward	(VGSF = 20 V)	IGSSF	1911190	1101111	500	nAdc
Gate-Body Leakage Current, Reverse	(V _{GSR} = -20 V)	IGSSR	i Ap oli cati	rai Conta	-500	nAdc
N CHARACTERISTICS		N.	Capabilit	Vall Power	A sloer	mem
Gate Threshold Voltage (I _D = 250 μA, V _{DS} = V _{GS})		VGS(th)	2.0	Ballu	4.0	Vdc
Static Drain-Source On-Resistance (1 (VGS = 10 Vdc, I _D = 0.4 A)) IRFD220 IRFD223	R _{DS(on)}	=	_	0.8 1.2	Ohms
On-State Drain Current (1) (VGS = 10 V, VDS = 5.0 V)	I _{D(on)}	0.8 0.7	_	_	Adc	
Forward Transconductance (1) (I _D = 0.4 A, V _{DS} = 5.0 V)		9FS	0.5	_	_	mhos
APACITANCE	T					
Input Capacitance	3760	C _{iss}	_	_	600	pF
Output Capacitance	(V _{DS} = 25 V, V _{GS} = 0, f = 1.0 MHz)	Coss	_	_	300	
Reverse Transfer Capacitance	MIJUS-5	C _{rss}	saethu 3°a	C = (T) & D	80	MIKAN
WITCHING CHARACTERISTICS	10dmy2		entlefi			
Turn-On Delay Time	asov	^t d(on)	_	- 60	40	ns
Rise Time	(V _{DS} ≈ 0.5 V _{(BR)DSS} ,	t _r	_	_	60	Drain-C
Turn-Off Delay Time	$I_D = 0.4 \text{ A}, Z_0 = 50 \Omega$	^t d(off)	_		100	(AG8
Fall Time	2eV	t _f	_	- 96	60	Galle-B
OURCE-DRAIN DIODE CHARACTE	RISTICS		3,98 = 0	ontinuous T	O - Terriu	Depin G
Diode Forward Voltage ($V_{GS} = 0$) $I_S = 0.8$ A, IRFD220 $I_S = 0.7$ A, IRFD223		VF		Bloom & TC	2.0 1.8	Vdc
Continuous Source Current, Body Diode IRFD220		Is	etur e t lang	age Te rnge	0.8 0.7	Adc
Pulsed Source Current, Body Diode	IRFD220 IRFD223	ISM	1108 -	ACTERIS	6.4 5.6	A
Forward Turn-On Time	(In Dated In Van O	ton		negligible	fsie julija	ns
Reverse Recovery Time	$(I_S = Rated I_S, V_{GS} = 0)$	t _{rr}	_	150	_	1

^{1.} Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

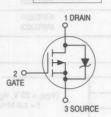
TMOS Field Effect Transistor Dual In-Line Package

P-Channel Enhancement Mode

- Ideal for Peripheral Control Applications
- Intermediate 1 Watt Power Capability
- Standard DIP Outline

IRFD9120 IRFD9123

> TMOS FET TRANSISTORS FET DIP



TMOS



MAXIMUM RATINGS (TA = 25°C unless otherwise noted)

Rating			Symbol	IRFD9120	IRFD9123	Unit
Drain-Source Voltage	(((0))))		VDSS	100	60	Vdc
Drain-Gate Voltage (R _{GS} = 20 kΩ)	(No)b)	$Z_0 = 50 \Omega$	VDGR	100	60	Vdc
Gate-Source Voltage	9		VGS	±20		Vdc
Drain Current — Continuous T _C = 25°C — Pulsed	aV 11		I _D	1.0 8.0	0.8 6.4	Adc
Total Power Dissipation @ T _C = 25°C Derate above 25°C	91		PD	The second second second	.0	Watts mW/°C
Operating and Storage Temperature Range			T _J , T _{stg}	-55 to	0 +150	°C

THERMAL CHARACTERISTICS

1.0			
Thermal Resistance — Junction-to-Ambient	R ₀ JA	120	°C/W
(Free Air Operation)			Forward Turn

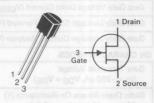
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Charac	teristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS							
Drain-Source Breakdown Voltage (V _{GS} = 0, I _D = -250 μA)	IRFD9120 IRFD9123		V _{(BR)DSS}	100 60	_	_	Vdc
Zero Gate Voltage Drain Current (VDS	SS = Rated V _{DSS} , V _{GS}	= 0 V)	IDSS	_	_	250	μAdc
Gate-Body Leakage Current, Forward	(VGSF = -20 V)		IGSSF	_	_	500	nAdo
Gate-Body Leakage Current, Reverse	(V _{GSR} = 20 V)		IGSSR	_	_	500	nAdc
ON CHARACTERISTICS					8	BATING	MUMB
Gate Threshold Voltage (I _D = -250 μA, V _{DS} = V _{GS})	Unit	Value - 35	VGS(th)	2.0		4.0	Vdc
Static Drain-Source On-Resistance (1 (V _{GS} = -10 Vdc, I _D = -0.8 A)) IRFD9120 IRFD9123	- 35	R _{DS(on)}	_	_	0.6 0.8	Ohms
On-State Drain Current (1) (VGS = 10 V, VDS = -5.0 V)	IRFD9120 IRFD9123	350	I _{D(on)}	1.0 0.8	= 41 (9)	toire siic	Adc
Forward Transconductance (1) (I _D = -0.8 A, V _{DS} = -5.0 V)	5'	300	9FS	0.8	-	- 10	mhos
CAPACITANCE		931 9 01 0	gte - L.		09850411	Epacific	D76 regri
Input Capacitance			C _{iss}	_	_	450	pF
Output Capacitance	$(V_{DS} = -25 \text{ V}, V_{DS})$ f = 1.0 MHz		Coss	= AII ex	1014510	350	CIRROR
Reverse Transfer Capacitance	ledinys 1 - 1.0 km	12)	C _{rss}	ny portugit?		100	
SWITCHING CHARACTERISTICS						- T	denes to
Turn-On Delay Time	COINET		^t d(on)	_	-	50	ns
Rise Time	(V _{DS} ≈ 0.5 V _{(E}	BR)DSS,	t _r	_	1-1	100	ретамой
Turn-Off Delay Time	$I_D = -0.8 \text{ A}, \dot{Z}_0$	$=50 \Omega$)	td(off)		_	100	2
Fall Time 0.8-	MolSio V		tf	_	1/4 o 0	100	Source ve = 5.0
SOURCE-DRAIN DIODE CHARACTER	RISTICS	SPIL					
Diode Forward Voltage ($V_{GS} = 0$) $I_S = -1.0 \text{ A}$, IRFD9120 $I_S = -0.8 \text{ A}$, IRFD9123		VF	=		6.3 6.0	Vdc	
Continuous Source Current, Body Diode IRFD9120 IRFD9123		IS	=	=	1.0 0.8	Adc	
Pulsed Source Current, Body Diode	IRFD9120 IRFD9123	Differ.	ISM	_	768[255]	8.0 6.4	А
Forward Turn-On Time	(la Poted la l	J113	ton		negligible		ns
Reverse Recovery Time	(I _S = Rated I _S ,	VGS = 0)	t _{rr}	_	150	nD <u>ar</u> n n	niesQ :

^{1.} Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

J111 thru J113

CASE 29-04, STYLE 5 TO-92 (TO-226AA)



JFET CHOPPER TRANSISTORS

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

MACHINE MILITARIO							
Rating — 0.3	Symbol	Value	Unit				
Drain-Gate Voltage	V _{DG}	-35	Vdc				
Gate-Source Voltage	VGS	-35	Vdc				
Gate Current	IG	50	mA				
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C				
Lead Temperature	TLS99	300	°C				
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +150	°C				

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

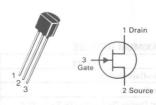
Refer to MPF4391 for graphs.

Characte	ristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	5010			The state of the s		
Gate-Source Breakdown Voltage $(I_G = -1.0 \mu A)$	(no)b)		V(BR)GSS	35	sasi yaledin	Vdc
Gate Reverse Current (VGS = -15 V)	yl.		I GSS	_	-1.0	nA
Gate Source Cutoff Voltage (V _{DS} = 5.0 V, I _D = 1.0 μA)	12	J111	VGS(off)	-3.0	-10	V
Law Lea L. L.		J112 J113	TERRISTICS CENTER	-1.0 -0.5	-5.0 -3.0	SOURCE
Drain-Cutoff Current (V _{DS} = 5.0 V, V _{GS} = -10 V)			ID(off)	_	1.0	nA
ON CHARACTERISTICS			STEUDEN SUGGE	france windstate	Dall-up com	ROHENCE -
Zero-Gate-Voltage Drain Current* (V _{DS} = 15 V)	MSI		IDSS	20 5.0	Source Curr	mA
en edigipan	nol l	J113		2.0	of no-mail b	Forwar
Static Drain-Source On Resistance (V _{DS} = 0.1 V)	al I	J111 J112 J113	rDS(on)	gent sy 808 > rifbit	30 50 100	Ohms
Drain Gate and Source Gate On-Capacitance ($V_{DS} = V_{GS} = 0$, $f = 1.0$ MHz)			C _{dg(on)} + C _{sg(on)}		28	pF
Drain Gate Off-Capacitance √GS = −10 V, f = 1.0 MHz)			C _{dg(off)}		5.0	pF
Source Gate Off-Capacitance (VGS = -10 V, f = 1.0 MHz)		Middle	C _{sg(off)}	-	5.0	pF

^{*}Pulse Width = 300 μ s, Duty Cycle = 3.0%.

J202 J203

CASE 29-04, STYLE 5 TO-92 (TO-226AA)



JFETs LOW FREQUENCY/LOW NOISE

N-CHANNEL — DEPLETION

Refer to 2N5457 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	40	Vdc
Drain-Gate Voltage	V _{DG}	40	Vdc
Gate-Source Voltage	VGS	40	Vdc
Gate Current	IG	50	mA
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	310 2.82	mW mW/°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

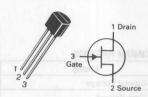
	Characteristic		Symbol	Min	Max	Unit	
OFF CHARACTERISTICS	Vierioss		opalloV away as is sam				
Gate-Source Breakdown Voltage $(I_G = -1.0 \mu A)$	less l		V(BR)GSS	-40	TO A H I BS	Vdc	
Gate Reverse Current (VGS = -20 V)	Vesion		IGSS	9.0	-100	pA	
Gate Source Cutoff Voltage (Vps = 20 V, Ip = 10 nA)		J202 J203	VGS(off)	-0.8 -2.0	-4.0 -10.0	Vdc	
ON CHARACTERISTICS) = . V 0	Yos P	
Zero-Gate-Voltage Drain Current (VDS = 20 V)	Mapv	J202 J203	IDSS*	0.9 4.0	4.5 20.0	mA	
SMALL-SIGNAL CHARACTERISTIC	S left			8096	Mint	Trawno Tr	
Forward Transfer Admittance (VDS = 20 V, f = 1.0 kHz)	IsoVi	J202 J203	Yfs *	1000 1500	0 3 V 5) 	μmhos Manualio E 20V)	

*Pulse Width ≤ 2.0 ms.

WAXIIVIOW RATINGS			
Rating	Symbol	Value	Unit
Drain-Gate Voltage	V _{DG}	- 25	Vdc
Gate Current	IG	10	mA
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW/°C
Lead Temperature (1/16" from Case for 10 Seconds)	TL	300	°C
Junction Temperature Range	TJ	-65 to +150	°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

J300

CASE 29-04, STYLE 5 TO-92 (TO-226AA)



JFET
HIGH FREQUENCY AMPLIFIER

N-CHANNEL — DEPLETION

Refer to 2N5484 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

	Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	lectimo2		Districtoristic			
Gate-Source Breakdown Voltage (I _G = -1.0μ A, V _{DS} = 0)			V _(BR) GSS	- 25	ome rc mov	Vdc
Gate Reverse Current (VGS = -15 V, V _{DS} = 0)	oconne)*		IGSS	Dietar.	500	pA
Gate Source Cutoff Voltage (V _{DS} = 10 V, I _D = 1.0 mA)			VGS(off)	-1.0	-6.0	Vdc
ON CHARACTERISTICS	11(0)(0)	COS4.		UAO C	it = al V 0	fyryg = 2
Zero-Gate-Voltage Drain Current (VDS = 10 V, VGS = 0)		1203	IDSS	6.0	30	mA
Gate-Source Forward Voltage (VDS = 0, IG = 1.0 mA)	*280	eaci	V _{GS(f)}	m e nu2	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS		5054				
Forward Transfer Admittance (VDS = 10 V, ID = 5.0 mA, f = 1.	0 kHz)		Yfs	4500	9000	μmhos
Output Admittance $(V_{DS} = 10 \text{ V, I}_{D} = 5.0 \text{ mA, f} = 1.0 \text{ M}$	0 kHz)	205L 205L	Yos	-1818	200	μmhos
Input Capacitance $(V_{DS} = 10 \text{ V}, I_{D} = 5.0 \text{ mA}, f = 1.0 \text{ m})$	0 MHz)		C _{iss}		5.5	pF
Reverse Transfer Capacitance (V _{DS} = 10 V, I _D = 5.0 mA, f = 1.	.0 MHz)		C _{rss}		1.7	pF

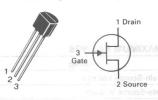
1308 thru 1310* case 20-04, STYLE 6

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V _{DG}	met -30	Vdc
Gate-Source Voltage	VGS	-30	Vdc
Gate Current	IG	10	mA
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW/°C
Lead Temperature (1/16" from Case for 10 Seconds)	TL	300	°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +150	°C

J304 J305

CASE 29-04, STYLE 5 TO-92 (TO-226AA)



JFET HIGH FREQUENCY AMPLIFIERS

N-CHANNEL — DEPLETION

Refer to 2N5484 for graphs.

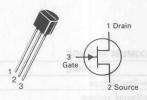
ELECTRICAL	CHARACTERISTICS	/TA = 25°C unless	otherwise noted

			Characte	eristic		Symbol	Min	Max	Unit
OFF CHAI	RACTERISTIC	s	- 20-	Walliage	- I		Anetic	A number Late B	Sate-Source
	ce Breakdow 0 μA, V _{DS} =			525-52 (716-2		V _(BR) GSS	30 [0	= ac - Aq 0	Vdc
	rse Current -20 V, V _{DS}	; = 0)				IGSS (O	0, 1 2 - 25 0, 1 ₄ = +	= 30100 ar	= pAV)
	rce Cutoff Vol 15 V, I _D = 1		-1.0 -1.0	Vestern	J304 3001 J305 0001	VGS(off)		0.1 -6.0 (0 -3.0	Vdc agV)
ON CHAR	ACTERISTIC	S	- 2.0		DIEL				
	-Voltage Drai 15 V, V _{GS} =		51	eaci	J304 J305	IDSS	5.0	15 8.0	mA V-ass3-ore
SMALL-S	IGNAL CHAR	ACTERIST	rics		1309	•			
Output Ad (V _{DS} =	Imittance 15 V, V _{GS} =	= 0, f = 1.	0 kHz)	Vesm	U-state -	Yos	#gs	50	μmhos
	ransconduct 15 V, VGS =		0 kHz)		J304 J305	Re(y _{fs})	4500 3000	7500	μmhos
	=	T 0 T 0 8.0			BOEL OTEL	WHZ)	001 = 1.An	101 = 3 V	if = SQV)

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	25	Vdc
Gate-Source Voltage	VGS	Am 25	Vdc
Forward Gate Current	IGF	10	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Junction Temperature Range	TJ	-65 to +125	°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

J308 thru J310*

CASE 29-04, STYLE 5 TO-92 (TO-226AA)



JFET VHF/UHF AMPLIFIERS

N-CHANNEL — DEPLETION

★These are Motorola designated preferred devices.

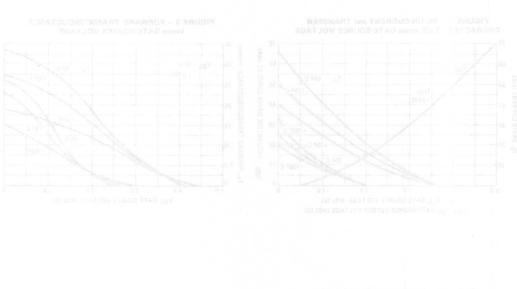
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

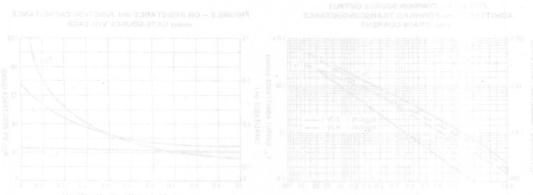
Char	acteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	108m/s			Chemical			
Gate-Source Breakdown Voltage (I _G = -1.0 μA, V _{DS} = 0)	V(ea)GSS		V _(BR) GSS	- 25	ess wn Veltage	AGT <u>E</u> SENT is Brenkdo	Vdc
Gate Reverse Current (VGS = -15 V, VDS = 0, TA = 25 (VGS = -15 V, VDS = 0, TA = +			IGSS	=	(0 = g	-1.0 -1.0	nA μA
Gate Source Cutoff Voltage (V _{DS} = 10 V, I _D = 1.0 nA)	Vestotti	J308 J309 J310	VGS(off)	-1.0 -1.0 -2.0	Agklic (A=10.1	-6.5 -4.0 -6.5	Vdc
ON CHARACTERISTICS	lnac				toeven't ob	of another	-8287)-0181
Zero-Gate-Voltage Drain Current(1) (V _{DS} = 10 V, V _{GS} = 0)		J308 J309 J310	IDSS	12 12 24	= 0) BACITAIST	60 30 60	mA
Gate-Source Forward Voltage (VDS = 0, IG = 1.0 mA)	lag Vi		V _{GS(f)}	(sF6) (deta-	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS	(51/1010	LINOS .		16964	1.0 = 1.0 =	may V. V. at	Water or
Common-Source Input Conductance ($V_{DS} = 10 \text{ V}, I_D = 10 \text{ mA}, f = 100 \text{ mA}$	MHz)	J308 J309 J310	Re(y _{is})	=	0.7 0.7 0.5		mmhos
Common-Source Output Conductance (VDS = 10 V, ID = 10 mA, f = 100			Re(yos)	-	0.25	-	mmhos
Common-Gate Power Gain (VDS = 10 V, ID = 10 mA, f = 100	MHz)		G _{pg}	-	16	7-	dB
Common-Source Forward Transcond ($V_{DS} = 10 \text{ V}, I_D = 10 \text{ mA}, f = 100 \text{ m}$			Re(yfs)		12	_	mmhos
Common-Gate Input Conductance $(V_{DS} = 10 \text{ V}, I_D = 10 \text{ mA}, f = 100 \text{ m})$	MHz)		Re(y _{ig})	-	12	-	mmhos
Common-Source Forward Transcond ($V_{DS} = 10 \text{ V}, I_D = 10 \text{ mA}, f = 1.0$		J308 J309 J310	9fs	8000 10000 8000	Ξ	20000 20000 18000	μmhos
Common-Source Output Conductanc ($V_{DS} = 10 \text{ V}, I_D = 10 \text{ mA}, f = 1.0$			gos	_	-	250	μmhos

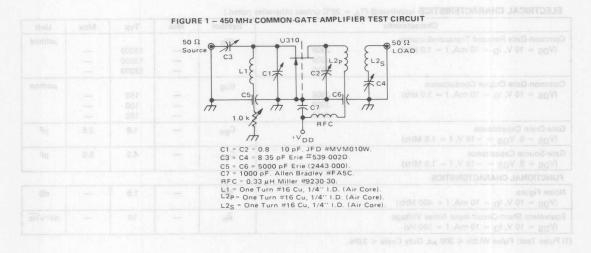
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

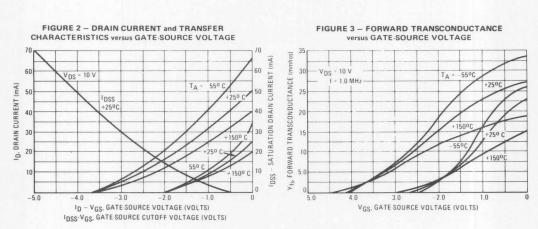
Characteristic	THE PART OF THE PROPERTY OF	Symbol	Min	Тур	Max	Unit
Common-Gate Forward Transconductance ($V_{DS} = 10 \text{ V}$, $I_{D} = 10 \text{ mA}$, $f = 1.0 \text{ kHz}$)	J308 J309 J310	9fg	008 — 1008 —	13000 13000 12000	_	μmhos
Common-Gate Output Conductance ($V_{DS} = 10 \text{ V}, I_D = 10 \text{ mA}, f = 1.0 \text{ kHz}$)	J308 J309 J310	gog	_	150 100 150	_	μmhos
Gate-Drain Capacitance (V _{DS} = 0, V _{GS} = -10 V, f = 1.0 MHz)	91M 9	C _{gd}	_	1.8	2.5	pF
Gate-Source Capacitance $(V_{DS} = 0, V_{GS} = -10 \text{ V}, f = 1.0 \text{ MHz})$	8.35 of East #639-002D. 5.35 of East #639-002D. 5000 of East (#443-000)	C _{gs}	_	4.3	5.0	pF
FUNCTIONAL CHARACTERISTICS	BF AHAR BOSON REASONS AN ASIN SON SON SON SON SON SON SON SON SON SO	0007 ± 50 50 4 338				
Noise Figure $(V_{DS} = 10 \text{ V}, I_{D} = 10 \text{ mA}, f = 450 \text{ MHz})$	Fain #16 Cu 1/6" 1 D. 1Air Corel Turn #16 Cu, 1/4" 1 D. [Air Corel Turn #16 Cu, 1/4" 1 D. [Air Cond	INF	_	1.5	_	dB
Equivalent Short-Circuit Input Noise Voltage (VDS = 10 V, ID = 10 mA, f = 100 Hz)		ē _n	_	10	_	nV/√Hz

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 3.0%.









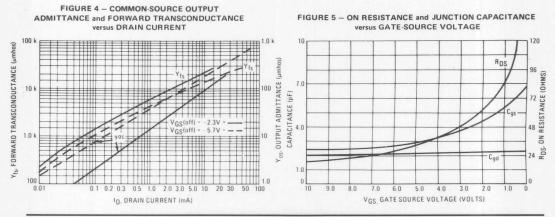


FIGURE 6 – COMMON-GATE Y PARAMETER MAGNITUDE versus FREQUENCY

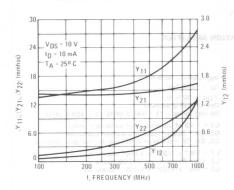


FIGURE 7 – COMMON-GATE S PARAMETER MAGNITUDE versus FREQUENCY

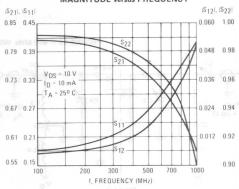


FIGURE 8 – COMMON-GATE Y PARAMETER PHASE-ANGLE versus FREQUENCY

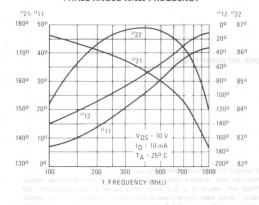


FIGURE 9 - S PARAMETER PHASE-ANGLE

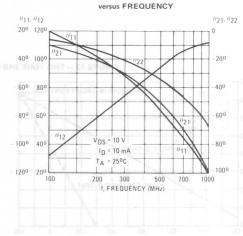


FIGURE 10 - NOISE FIGURE and POWER GAIN versus DRAIN CURRENT

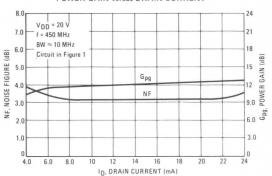


FIGURE 11 — NOISE FIGURE and POWER GAIN versus FREQUENCY

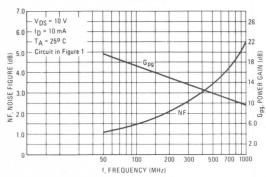
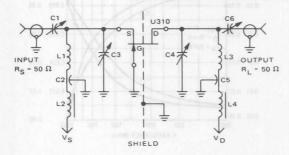


FIGURE 12 - 450 MHz IMD EVALUATION AMPLIFIER

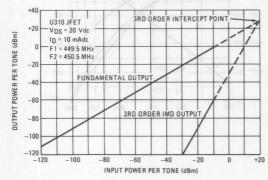


B_W (3dB) = 36.5 MHz I_D = 10 mAdc V_{DS} = 20 Vdc Device case grounded IM test tones = f1 = 449.5 MHz, f2 = 450.5 MHz C1 = 1.10 pf Johanson Air variable trimmer. C2, C5 = 100 pf feed thru button capacitor. C3, C4, C6 = 0.5-6 pf Johanson Air variable trimmer.

L1 = 1/8" x 1/32" x 1·5/8" copper bar L2, L4 = Ferroxcube Vk200 choke. L3 = 1/8" x 1/32" x 1·7/8" copper bar.

Amplifier power gain and IMD products are a function of the load impedance. For the amplifier design shown above with C4 and C6 adjusted to reflect a load to the drain resulting in a nominal power gain of 9 dB, the 3rd order intercept point (IP) value is 29 dBm. Adjusting C4, C6 to provide larger load values will result in higher gain, smaller bandwidth and lower IP values. For example, a nominal gain of 13 dB can be achieved with an intercept point of 19 dBm.





Example of intercept point plot use:

Assume two in-band signals of -20 dBm at the amplifier input. They will result in a 3rd order IMD signal at the output of -90 dBm. Also, each signal level at the output will be -11 dBm, showing an amplifier gain of 9.0 dB and an intermodulation ratio (IMR) capability of 79 dB. The gain and IMR values apply only for signal levels below compression.

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DSS}	60	Vdc
Drain-Gate Voltage	V _{DGS}	60	Vdc
Gate-Source Voltage — Continuous — Non-repetitive (t _p ≤ 50 μs)	V _{GS}	± 20 ± 40	Vdc Vpk
Drain Current — Continuous Pulsed	I _D	0.5 0.8	Adc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

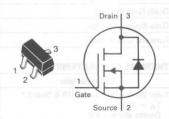
*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBF170LT1 = 6Z

MMBF170LT1

CASE 318-07, STYLE 21 SOT-23 (TO-236AB)



TMOS FET TRANSISTOR

N-CHANNEL

Refer to 2N7000 for graphs.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

	Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	asstual,		(0)	e say anAu () fraini)
Drain-Source Breakdown Voltage	$(V_{GS} = 0, I_{D} = 100 \mu\text{A})$	V(BR)DSS	60	(osc. T) earl	Vdc
Gate-Body Leakage Current, Forw	ard (V _{GSF} = 15 Vdc, V _{DS} = 0)	IGSS	o. 1 ₁₀ -25°	20 10 V 31	nAdc
ON CHARACTERISTICS*		197	001 = V1 '0 =	S0 : m. / c1	= S9A3
Gate Threshold Voltage (V _{DS} = V	$'_{GS}$, $I_{D} = 1.0 \text{ mA}$)	V _{GS(th)}	0.8	3.0	Vdc
Static Drain-Source On-Resistance (V _{GS} = 10 Vdc, I _D = 200 mA)		rDS(on)		5.0	Ohm
On-State Drain Current (VDS = 25	5 V, V _{GS} = 0)	ID(off)	_	0.5	μΑ
DYNAMIC CHARACTERISTICS	(flo)Ql			frant III nant	Off-State (
Input Capacitance (V _{DS} = 10 V, V _{GS} = 0 V, f = 1	.0 MHz)	Ciss	: -12 Vdc, T	60	pF
SWITCHING CHARACTERISTICS*				Union store	MARD NO
Turn-On Delay Time	(V _{DD} = 25 V, I _D = 500 mA, R _{gen} = 50 Ohms)	td(on)	TON I C.F.	10	ns
Turn-Off Delay Time	Figure 1	td(off)	_	10	0.017

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

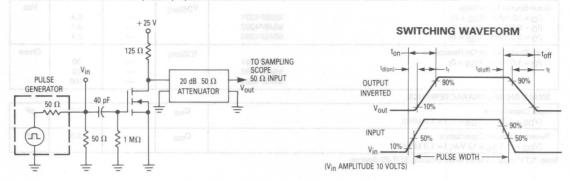


Figure 1. Switching Test Circuit

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	30	Vdc
Drain-Gate Voltage	V _{DG}	30	Vdc
Gate-Source Voltage	V _{GS}	30	Vdc
Forward Gate Current	IG(f)	50	mAdo

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBF4391LT1 = 6J; MMBF4392LT1 = 6K; MMBF4393LT1 = 6G

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

MMBF4391LT1 thru MMBF4393LT1*

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)





JFET SWITCHING TRANSISTORS

N-CHANNEL

★These are Motorola designated preferred devices.

Refer to MPF4391 for graphs.

C	haracteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS		Contest value wise Holaus)	all - No box	TORMITOR	INTO JAGO	re volum
Gate-Source Breakdown Voltage (I _G = 1.0 μAdc, V _{DS} = 0)	ludinys		V(BR)GSS	30	TRINSTOAR	Vdc
Gate Reverse Current (V _{GS} = 15 Vdc, V _{DS} = 0, T _A = 25°C) (V _{GS} = 15 Vdc, V _{DS} = 0, T _A = 100°C	VIGSS (GSS)	160 JLA1 16 Vds Vps = 01	IGSS	own Voltage Lunan t, flory ce*	1.0 0.20	nAdc μAdc
Gate Source Cutoff Voltage (V _{DS} = 15 Vdc, I _D = 10 nAdc)	(D3(an)	MMBF4391 MMBF4392 MMBF4393	VGS(off)	-4.0 -2.0 -0.5	-10 -5.0 -3.0	Vdc
Off-State Drain Current (V _{DS} = 15 Vdc, V _{GS} = -12 Vdc) (V _{DS} = 15 Vdc, V _{GS} = -12 Vdc, T _A =	100°C)		^I D(off)	enerics - V n	1.0 1.0	nAdo μAdo
ON CHARACTERISTICS				and the same	IRRAHA SIR	MANAMA
Zero-Gate-Voltage Drain Current (VDS = 15 V, VGS = 0)		MMBF4391 MMBF4392 MMBF4393	IDSS	50 25 5.0	150 75 30	mAdd
Drain-Source On-Voltage (I _D = 12 mAdc, V _{GS} = 0) (I _D = 6.0 mAdc, V _{GS} = 0) (I _D = 3.0 mAdc, V _{GS} = 0)	re .	MMBF4391 MMBF4392 MMBF4393	VDS(on)	es + = 9 =	0.4 0.4 0.4	Vdc
Static Drain-Source On Resistance (I _D = 1.0 mAdc, V _{GS} = 0)	-noi e-noni TUTTUO	MMBF4391 MMBF4392 MMBF4393	rDS(on)	\$ 0 asr	30 60 100	Ohm
SMALL-SIGNAL CHARACTERISTICS	Q3/H3VM	100	INTERIOR TO		GB F	100000
Input Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz)	-	C _{iss}	-	14	pF
Reverse Transfer Capacitance (VDS = 0, VGS = 12 Vdc, f = 1.0 MHz	TURNE) TO I		C _{rss}	nmr § 1	3.5	pF

Note: "LT1" must be used when ordering SOT-23 devices.

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	30	Vdc
Drain-Gate Voltage	V _{DG}	30	Vdc
Gate-Source Voltage	V _{GS}	30	Vdc
Gate Current	IG	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBF4416LT1 = M6A

MMBF4416LT1*

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)





JFET VHF/UHF AMPLIFIER TRANSISTOR

N-CHANNEL

★This is a Motorola designated preferred device.

Refer to 2N5484 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

	Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	Visioner			nostioV	NAMES - 13	Gate-Sevice
Gate-Source Breakdown Voltage (I _G = 1.0 μ Adc, V _{DS} = 0)	sasi		V _(BR) GSS	30	Ag Q / _ gl	Vdc
Gate Reverse Current (V _{GS} = 20 Vdc, V _{DS} = 0) (V _{GS} = 20 Vdc, V _{DS} = 0, T _A = 1	150°C)		IGSS	(V 	1.0	nAdc nAdc
Gate Source Cutoff Voltage (I _D = 1.0 nAdc, V _{DS} = 15 Vdc)			VGS(off)	_	-6.0	Vdc
Gate Source Voltage (Ip = 0.5 mAdc, Vps = 15 Vdc)	2801		VGS	-1.0	-5.5	Vdc
ON CHARACTERISTICS	(10)[]			(V.0	r = per l' V 2	(Vos = 1
Zero-Gate-Voltage Drain Current (VGS = 15 Vdc, VGS = 0)	VBS(en)		IDSS	5.0	15	μAdc
Gate-Source Forward Voltage (I _G = 1.0 mAdc, V _{DS} = 0)	(no)80°1		V _{GS(f)}	507 IsHU 0.1	1.0	Vdc d
SMALL-SIGNAL CHARACTERISTICS	3	Value and A	n meN		THE STREET	Input Caper
Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0	kHz)	1-1.0 WHz	Y _{fs}	4500	7500	μmhos
Output Admittance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0	kHz)	Am De	Yos	T	50	μ mhos
Input Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0	MHz)	0. VGStorn = -10 V	C _{iss}	+	4.0	pF T 100-mu I
Reverse Transfer Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0) MHz)	.995	C _{rss}	æi 00 00 ≥ 11	0.8	n eapF (r)
Output Capacitance $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 1.0)$) MHz)		C _{oss}	_	2.0	pF
FUNCTIONAL CHARACTERISTICS						
Noise Figure $(V_{DS} = 15 \text{ Vdc}, I_{D} = 5.0 \text{ mAdc}, I_{C} = 15 \text{ Vdc}, I_{D} = 5.0 \text{ mAdc}, I_{C} = 15 \text{ Vdc}, I_{C}$			NF	=	2.0 4.0	dB
Common Source Power Gain (VDS = 15 Vdc, ID = 5.0 mAdc, 1 (VDS = 15 Vdc, ID = 5.0 mAdc, 1			G _{ps}	18 10	_	dB

MAXIMOM HATINGO			
epude S Rating	Symbol	Value	Unit
Drain-Gate Voltage	V _{DG}	25	V
Reverse Gate-Source Voltage	V _{GS(R)}	-25	V

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	TJ, T _{sta}	-55 to +150	°C

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBF4856LT1 = AAA

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

MMBF4856LT1*

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)





JFET SWITCHING

N-CHANNEL — DEPLETION

★This is a Motorola designated preferred device.

Refer to MPF4391 for graphs.

	Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	loderyd	pliahezadio	0		
Gate-Source Breakdown Voltage $(V_{DS} = 0, I_{D} = 1.0 \mu A)$	adp(ns)V	V _(BR) GSS	-40	averbiged8	٧
Gate Reverse Current (V _{DS} = 0 V, V _{GS} = 20 V)	880	IGSS	_ 10 =	0.5	nA
Gate Source Cutoff Voltage (VDS = 15, ID = 0.5 nA)		VGS(OFF)	-4.0	-10	V
ON CHARACTERISTICS	(Hol8aV		90	play horast	ie Source
Zero-Gate-Voltage Drain Current(1) (VGS = 0, VDS = 15 V)	SoV You	IDSS	50	egalloV s	mA
Drain Cutoff Current (V _{DS} = 15 V, V _{GS} = 10 V)		ID(off)		0.25	nA
Drain Source On Voltage (VGS = 0, ID = 20 mA)	1880	V _{DS(on)}	(0 = 0)	0.75	V
Drain Source On Resistance (VGS = 0, ID = 0, f = 1.0 kHz)	usav	rDS(on)	(0 =	25	Ω
Input Capacitance	$V_{DS} = 0, V_{GS} = -10 \text{ V}$	Ciss	SOFT MARTIN	18	MS-TIVV
Reverse Transfer Capacitance	f = 1.0 MHz	C _{rss}		8	pF
SWITCHING CHARACTERISTICS		1917	4.1 - 1.0	80.74	
Turn-On Delay Time	(epy)	t _d	0.1 = 1.0 +	6	= anv
Rise Time	$V_{DD} = 10 \text{ V}, I_{D(on)} = 20 \text{ mA}$ $V_{GS(on)} = 0, V_{GS(off)} = -10 \text{ V}$	t _r	_	3	nS
Turn-Off Time	vGS(on) - 0, vGS(off) 10 V	toff	0.1 =1.0	25	Yos = 1

(1) Pulse Test; Pulse Width < 300 μ s, Duty Cycle \le 2%.

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	30	Vdc
Drain-Gate Voltage	M VDG	30	Vdc
Reverse Gate-Source Voltage	V _{GS(r)}	30	Vdc
Forward Gate Current	I _{G(f)}	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* Τ _Α = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBF4860LT1 = M6F

MMBF4860LT1*

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)





JFET SWITCHING TRANSISTOR

N-CHANNEL

★This is a Motorola designated preferred device.

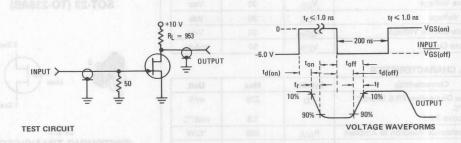
Refer to MPF4391 for graphs.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage (IG = 1.0 µAdc, VDS = 0)	V _(BR) GSS	30	_	Vdc
Gate Reverse Current $(V_{GS} = 15 \text{ Vdc}, V_{DS} = 0)$ $(V_{GS} = 15 \text{ Vdc}, V_{DS} = 0, T_A = 150^{\circ}\text{C})$	IGSS	=	0.5 2.0	nAdc μAdc
Gate Source Cutoff Voltage ($V_{DS}=$ 15 Vdc, $I_{D}=$ 0.5 nAdc)	VGS(off)	-2.0	-6.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current(1) $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0)$	IDSS	20	100	mAdc
Drain Cutoff Current ($V_{DS} = 15 \text{ Vdc}$, $V_{GS} = 10 \text{ Vdc}$) ($V_{DS} = 15 \text{ Vdc}$, $V_{GS} = 10 \text{ Vdc}$, $T_A = 150^{\circ}\text{C}$)	ID(off)	_	0.25 0.5	nAdc μAdc
Drain-Source On-Voltage (I _D = 10 mAdc, V _{GS} = 0)	V _{DS(on)}	_	0.5	Vdc
Static Drain-Source On Resistance $(V_{GS} = 0, I_D = 0, f = 1.0 \text{ kHz})$	rDS(on)	_	40	Ohms
Input Capacitance (Vps = 0, Vqs = 10 Vdc, f = 1.0 MHz)	C _{iss}	_	18	pF
Reverse Transfer Capacitance $(V_{DS} = 0, V_{GS} = 10 \text{ Vdc}, f = 1.0 \text{ MHz})$	C _{rss}	_	8.0	pF
SWITCHING CHARACTERISTICS				
Delay Time $(V_{DD} = 10 \text{ Vdc}, I_{D(on)} = 20 \text{ mAdc})$ $(V_{G(on)} = 0, V_{GS(off)} = 10 \text{ Vdc})$	t _d	_	6.0	ns
Rise Time $(V_{DD} = 10 \text{ Vdc}, I_{D(on)} = 10 \text{ mAdc})$ $(V_{GS(on)} = 0, V_{GS(off)} = 6.0 \text{ Vdc})$ (Figure 1)	t _r	_	4.0	ns
Turn-Off Time $(V_{DD} = 10 \text{ Vdc}, I_{D(on)} = 5.0 \text{ mAdc})$ $(V_{GS(on)} = 0, V_{GS(off)} = 4.0 \text{ Vdc})$ (Figure 1)	^t off	_	50	ns

(1) Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.

FIGURE 1 — SWITCHING TIMES TEST CIRCUIT



NOTES: 1. The input waveforms are supplied by a generator with the following characteristics:

Z_{nut} = 50 ohms, Duty Cycle ≈ 2.0%

Z_{out} = 50 ohms, Duty Cycle ≈ 2.0% 2. Waveforms are monitored on an oscilloscope with the following characteristics: t_r ≤ 0.75 ns, R_{In} ≥ 1.0 megohm, C_{In} ≤ 2.5 pF.

Rating	Symbol	Value	Unit	
Drain-Source Voltage	V _{DS}	25	Vdc	
Drain-Gate Voltage	V _{DG}	25	Vdc	
Reverse Gate-Source Voltage	V _{GS(r)}	25	Vdc	
Gate Current	IG	10	mAdo	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	mW/°C	
Total Device Dissipation FR-5 Board,* T _A = 25°C Derate above 25°C	PD	225		
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W	
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C	

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBF5457LT1 = 6D

MMBF5457LT1*

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTOR

N-CHANNEL

★This is a Motorola designated preferred device.

Refer to 2N5457 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteris	stic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS				8011	an in over	ARU TRU
Gate-Source Breakdown Voltage (I _G = 10 μAdc, V _{DS} = 0)	(AR)	V _(BR) GSS	25	0 = 0	10 L. V	Vdc
Gate Reverse Current (VGS = 15 Vdc, VDS = 0) (VGS = 15 Vdc, VDS = 0, TA = 100°C)	ren les	IGSS	_	10 = 50 10 = 20 10 = 30	1.0 200	nAdc
Gate Source Cutoff Voltage (V _{DS} = 15 Vdc, I _D = 10 nAdc)	iaoV	VGS(off)	0.5	/ 02 = 07 FA	-6.0	Vdc
Gate Source Voltage $(V_{DS} = 15 \text{ Vdc}, I_D = 100 \mu \text{Adc})$		VGS	_	-2.5	E PATDAR	Vdc
ON CHARACTERISTICS				Orain Current	4152KW-8	Zero-Gate
Zero-Gate-Voltage Drain Current(1) (VDS = 15 Vdc, VGS = 0)		IDSS	1.0	ARACTERIS	5.0	mAdc
SMALL-SIGNAL CHARACTERISTICS	Y			eanraimh	A ukumyi	Porward
Forward Transfer Admittance(1) (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz)	οΨ	Yfs	1000	# T_O = 1	5000	μmhos
Reverse Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz)		Yrs	(<u>set</u> at 0.	10	50	μmhos
Input Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)	n)	C _{iss}	ISHM 0.	4.5	7.0	pF
Reverse Transfer Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)		C _{rss}	(<u>s</u>]-(<u>i</u>)-(<u>s</u>)	1.5	3.0	pF

(1) Pulse test: Pulse Width ≤ 630 ms; Duty Cycle ≤ 10%.

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V _{DG}	25	Vdc
Reverse Gate-Source Voltage	V _{GS} (r)	-25	Vdc
Gate Current	IG	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBF5459LT1 = 6L

MMBF5459LT1*

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)





JFET TRANSISTOR

N-CHANNEL

★This is a Motorola designated preferred device.

Refer to 2N5457 for graphs.

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS			OF PERSONAL	makes was
Gate-Source Breakdown Voltage (I _G = -10 μA, V _{DS} = 0)	V(BR)GSS	25	e Breakdow	Vdc
Gate 1 Leakage Current (VGS = -15 V, VpS = 0)	I _{G1SS}	- in -	1.0	nA
Gate 2 Leakage Current (VGS = -15 V, VDS = 0, TA = 100°C)	I _{G2SS}	$= \sqrt{\frac{\pi}{T}} \sqrt{1 - \pi}$	200	nA
Gate Source Cutoff Voltage (V _{DS} = 15 V, I _D = 10 nA)	VGS(off)	-2.0	-8.0	Vdc
ON CHARACTERISTICS		(obAu, 001	a of aby a	- agV)
Zero-Gate-Voltage Drain Current (Vps = 15 V, Vgs = 0)	IDSS	4.0	16	mA
SMALL-SIGNAL CHARACTERISTICS		(0 =	15 Vdo Vas	= goV1
Forward Transfer Admittance (Vps = 15 V, Vgs = 0, f = 1.0 kHz)	Y _{fs}	2000	6000	μmhos
Output Admittance (Vps = 15 V, Vgs = 0, f = 1.0 kHz)	Yos	- 0, + - 1.0	50	μmhos
Input Capacitance (Vps = 15 V, Vgs = 0, f = 1.0 MHz)	C _{iss}	= 0,+= 1.0	7.0	pF
Reverse Transfer Capacitance (Vps = 15 V, Vgs = 0, f = 1.0 MHz)	C _{rss}	= 0, + = 1.0	3.0	pF

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V _{DG}	40	Vdc
Reverse Gate-Source Voltage	VGSR	40	Vdc
Forward Gate Current	IGF	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBF5460LT1 = 6E

MMBF5460LT1*

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)





JFET GENERAL PURPOSE TRANSISTOR

P-CHANNEL

★This is a Motorola designated preferred device.

Refer to 2N5460 for graphs.

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS			(59)	TE RELIDAN	DIFF CHA
Gate-Source Breakdown Voltage (I _G = 10 μAdc, V _{DS} = 0)	V(BR)GSS	40	wn <u>Vo</u> ltage s = 01	N As h.	Vdc
Gate Reverse Current $(V_{GS} = 20 \text{ Vdc}, V_{DS} = 0)$ $(V_{GS} = 20 \text{ Vdc}, V_{DS} = 0, T_A = 100^{\circ}\text{C})$	lgss	(<u>00</u> °C)	10 - 20 15 - 20 TA	5.0 1.0	nAdc μAdc
Gate Source Cutoff Voltage (V _{DS} = 15 Vdc, I _D = 1.0 μAdc)	V _{GS(off)}	0.75	enstio (An 01	6.0	Vdc
Gate Source Voltage (V _{DS} = 15 Vdc, I _D = 0.1 mAdc)	VGS	0.5	CS	4.0	Vdc
ON CHARACTERISTICS			(0 =	any / at	= sqV)
Zero-Gate-Voltage Drain Current (VDS = 15 Vdc, VGS = 0)	IDSS	-1.0	NACTERIE mittered	-5.0	mAdc
SMALL-SIGNAL CHARACTERISTICS		(x/9) 0	1 = 1,0 =	any var	- SQAI
Forward Transfer Admittance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 kHz)	Y _{fs}	1000	= 1.0 =	4000	μmhos
Output Admittance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 kHz)	lyosl	(sHM 0	= 1,0 =	75	μ mhos
Input Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)	C _{iss}	(sHM 0.	5.0	7.0	pF
Reverse Transfer Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)	C _{rss}	(SHRA O.	1.0	2.0	PF
Equivalent Short-Circuit Input Noise Voltage (VDS = 15 Vdc, VGS = 0, RG = 1.0 M Ω , f = 100 Hz, BW = 1.0 Hz)	e _n	_ 8. n 0.7 = 10	20	MAL <u>O</u> S AN	nV/√Hz

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V _{DG}	25	Vdc
Reverse Gate-Source Voltage	VGS(r)	25	Vdc
Forward Gate Current	IG(f)	10	mAdc
Continuous Device Dissipation at or Below T _C = 25°C Linear Derating Factor	PD	200 2.8	mW mW/°C
Storage Channel Temperature Range	T _{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

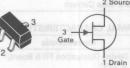
*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBF5484LT1 = 6B

MMBF5484LT1*

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)



JFET TRANSISTOR

N-CHANNEL

★This is a Motorola designated preferred device.

Refer to 2N5484 for graphs.

Characteristic Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS		9	OTERITOA	SANO 330
Gate-Source Breakdown Voltage (I _G = -1.0 μA, V _{DS} = 0)	V _(BR) GSS	- 25	e Breakdow	Vdc
Gate Reverse Current (VGS = -20 V, VDS = 0) (VGS = -20 V, VDS = 0, TA = 100°C)	Igss	_(0 =	-1.0 -0.2	nA μA
Gate Source Cutoff Voltage (V _{DS} = 15 V, I _D = 10 nA)	V _{GS(off)}	-0.3	-3.0	Vdc
ON CHARACTERISTICS			en stieV e	Oktu Seine
Zero-Gate-Voltage Drain Current (Vps = 15 V, Vgs = 0)	IDSS	(ab 1.0 1.0	5.0	mAdc
SMALL-SIGNAL CHARACTERISTICS		Concent		
Forward Transfer Admittance (Vps = 15 V, Vgs = 0, f = 1.0 kHz)	Y _{fs}	3000	6000	μmhos
Output Admittance (Vps = 15 V, Vgs = 0, f = 1.0 kHz)	lyosl	000801	50	μmhos
Input Capacitance (Vps = 15 V, Vgs = 0, f = 1.0 MHz)	C _{iss}	1 = 1.6 =	5.0	pF
Reverse Transfer Capacitance (Vps = 15 V, Vgs = 0, f = 1.0 MHz)	C _{rss}	- 0.4 a 1.0	1.0	pF
Output Capacitance (Vps = 15 V, Vgs = 0, f = 1.0 MHz)	Coss	Ganeric LL = 1.0 =	2.0	pF
FUNCTIONAL CHARACTERISTICS	Armfin'V	sind tunish	00013-00-12	resultandam's
Noise Figure (Vps = 15 V, lp = 1.0 mA, YG' = 1.0 mmhos)	NF	= 0, 8 _G = 0 Hz)	16 Vac. Vas Hz BW = 1	dB
$(R_{G} = 1.0 \text{ k}\Omega, f = 100 \text{ MHz})$ $(V_{DS} = 15 \text{ V}, V_{GS} = 0, YG' = 1.0 \mu\text{mho})$ $(R_{G} = 1.0 \text{ M}\Omega, f = 1.0 \text{ kHz})$		Ι	3.0 2.5	
Common Source Power Gain (Vps = 15 Vdc, Ip = 1.0 mAdc, f = 100 MHz)	G _{ps}	16	25	dB

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V _{DG}	25	Vdc
Reverse Gate-Source Voltage	V _{GS(r)}	25	Vdc
Forward Gate Current	I _{G(f)}	10	mAdo

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBF5486LT1 = 6H

MMBF5486LT1*

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)





JFET TRANSISTOR

N-CHANNEL

★This is a Motorola designated preferred device.

Refer to 2N5484 for graphs.

	Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS		307	3	200 - 0 000	and a
Gate-Source Breakdown Voltage (V _{DS} = 0, I _G = -1.0 μA)	sap.sa)V	V _(BR) GSS	- 25	result -T	Vdc
Gate 1 Leakage Current (VGS = -20 V, V _{DS} = 0)	8301	I _{G1SS}	- rv	-1.0	nA
Gate 2 Leakage Current $(V_{GS} = -20 \text{ V}, V_{DS} = 0, T_A = 1)$	00°C)	IG2SS	- 10	-0.2	μΑ
Gate Source Cutoff Voltage (V _{DS} = 15 V, I _D = 10 nA)		V _{GS(off)}	-2.0	-6.0	Vdc
ON CHARACTERISTICS	Dag		THE CHARLES	121	= 25V)
Zero-Gate-Voltage Drain Current (VGS = 0, VDS = 15 V)	(P(a)C)	IDSS	8.0	20	mA
SMALL-SIGNAL CHARACTERISTICS	144/261		830	er in Health	rein Sour
Forward Transfer Admittance (VGS = 0, VDS = 15 V, f = 1.0 kH	tz)	Yfs	4000	8000	μmhos
Input Admittance (VGS = 0, VDS = 15 V, f = 400 N	(Hz)	Re(yis)	Teprie	1000	μmhos
Output Admittance $(V_{GS} = 0, V_{DS} = 15 \text{ V}, f = 1.0 \text{ k})$	Hz)	Yos	mg 00e 0- 10	75	μmhos
Output Conductance · (VGS = 0, VDS = 15 V, f = 400 N	/IHz)	Re(yos)	_	100	μmhos
Forward Transconductance (VGS = 0, VDS = 15 V, f = 400 N	/IHz)	Re(y _{fs})	3500	_	μmhos
Input Capacitance $(V_{GS} = 0, V_{DS} = 15 \text{ V}, f = 1.0 \text{ M})$	Hz)	C _{iss}	_	5.0	pF
Reverse Transfer Capacitance $(V_{GS} = 0, V_{DS} = 15 \text{ V}, f = 1.0 \text{ M})$	Hz)	C _{rss}	_	1.0	pF
Output Capacitance $(V_{GS} = 0, V_{DS} = 15 \text{ V}, f = 1.0 \text{ M})$	Hz)	C _{oss}	_	2.0	pF
FUNCTIONAL CHARACTERISTICS					
	00 MHz, $Y_G = 1.0 \mu mhos$) 1.0 k Ω , f = 400 MHz, $Y_G = 1.0 \mu mhos$) $m\Omega$, f = 1.0 kHz, $Y_G = 1.0 \mu mhos$)	NF	=	2.0 4.0 2.5	dB
Common Source Power Gain (V _{DS} = 15 V, I _D = 4.0 mA, f = 10 (V _{DS} = 15 V, I _D = 4.0 mA, f = 40	DO MHz)	G _{ps}	18 10	30	dB

INFAINTON TEATHER						
Rating	Symbol	Value	Unit			
Drain-Gate Voltage	V _{DG}	25	V			
Reverse Gate-Source Voltage	V _{GS(r)}	-25	V			

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T _A = 25°C Derate above 25°C	PD	225 1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBFJ175LT1 = 6W

ELECTRICAL CHARACTERISTICS (T_A = 25°C, unless otherwise noted)

CH NAME CH	naracteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				SOLIEMENOS	F CHAR
Gate-Source Breakdown Voltage $(V_{DS} = 0, I_{D} = 1.0 \mu A)$	320(HB)V	V _(BR) GSS	30	16 = 1.0) = 80V
Gate Reverse Current (VDS = 0 V, VGS = 20 V)	lerss	IGSS	(0	1.0	nA
Gate Source Cutoff Voltage (VDS = 15, ID = 10 nA)	Gasa	V _{GS(OFF)}	3.0	6.0	٧
ON CHARACTERISTICS	CTERISTICS 0.5 (Ho)23V (1016) 201				
Zero-Gate-Voltage Drain Current(1) (VGS = 0, VDS = 15 V)		IDSS	7.0	60	mA
Drain Cutoff Current (VDS = 15 V, VGS = 10 V)	880	I _{D(off)}	<u>Imenul</u> (1	1.0	nA
Drain Source On Resistance (ID = 500 µA)		rDS(on)	enne Pros	125	Ω
Input Capacitance	V _{DS} = 0, V _{GS} = 10 V	Ciss	bl 0. <u>f_</u> = 1,	11	= 89/
Reverse Transfer Capacitance	f = 1.0 MHz	C _{rss}		5.5	pF

⁽¹⁾ Pulse Test; Pulse Width $< 300 \mu s$, Duty Cycle $\le 2\%$.

MMBFJ175LT1*

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)





JFET CHOPPER

P-CHANNEL — DEPLETION

★This is a Motorola designated preferred device.

Rating	Symbol	Value	Unit		
Drain-Gate Voltage	V _{DG}	25	or v		
Reverse Gate-Source Voltage	V _{GS(r)}	-25	V		

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit		
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW mW/°C		
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W	Ī	
Junction and Storage Temperature	TJ, T _{stq}	-55 to +150	°C		

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBFJ175LT1 = 6W

ELECTRICAL CHARACTERISTICS (T_A = 25°C, unless otherwise noted)

MMBFJ177LT1*

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)





JFET CHOPPER

P-CHANNEL — DEPLETION

★This is a Motorola designated preferred device.

	Characte	ristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	nille	Byrnbol		otherse	Char		
Gate-Source Breakdown Voltage $(V_{DS} = 0, I_{D} = 1.0 \mu A)$	us -	ann/csiV		V(BR)GSS	30	DR _INCS	V
Gate Reverse Current (V _{DS} = 0 V, V _{GS} = 20 V)		seal		IGSS	_(0 -	1.0	nA
Gate Source Cutoff Voltage (VDS = 15, ID = 10 nA)				V _{GS(OFF)}	0.8	2.5	- SOV
ON CHARACTERISTICS	0.3	VGS(off)	MINEF, 1309		95	erleV N u3	re Source
Zero-Gate-Voltage Drain Current(1) (VGS = 0, VDS = 15 V)	05-		UTELIJEMIN	IDSS	1.5	20	mA
Drain Cutoff Current (V _{DS} = 15 V, V _{GS} = 10 V)	12	880	MMBFJ3990 MMBFJ310	ID(off)	<u>-100</u> 07107	1.0	nA
Drain Source On Resistance (I _D = 500 μA)		Web/		rDS(on)	— tega:	300	Ω
Input Capacitance		$V_{DS} = 0, V_{G}$	is = 10 V	C _{iss}	SOFTERNST	0.09 A 11 B	DIS TT O
Reverse Transfer Capacitance		f = 1.0		C _{rss}	- (cn)	5.5	pF

(1) Pulse Test; Pulse Width < 300 μ s, Duty Cycle \leq 2%.

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	25	Vdc
Gate-Source Voltage	V _{GS}	25	Vdc
Gate Current	IG	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit			
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C Derate above 25°C	P _D 225		mW/°C			
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W			
Junction and Storage Temperature	TJ, Tsta	-55 to +150	°C			

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBFJ309LT1 = 6U; MMBFJ310LT1 = 6T

MMBFJ309LT1* MMBFJ310LT1*

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)





JFET VHF/UHF AMPLIFIER TRANSISTOR

N-CHANNEL

★These are Motorola designated preferred devices.

Refer to J309 for graphs.

Chara	cteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	zadusay (apatio V no	Bresidev	oruo@-edal
Gate-Source Breakdown Voltage (IG = -1.0 µAdc, VDS = 0)	290		V _(BR) GSS	-25	_ (A)	one Clarent	Vdc
Gate Reverse Current (VGS = -15 V) (VGS = -15 V, T _A = 125°C)	(410)86 ^V		IGSS		(V 0s Hageti —(An	-1.0 -1.0	nAdc μAdc
Gate Source Cutoff Voltage (V _{DS} = 10 Vdc, I _D = 1.0 nAdc)	and I	MMBFJ309 MMBFJ310	VGS(off)	-1.0 -2.0	s Current	-4.0 -6.5	Vdc
ON CHARACTERISTICS	000	WEST TRANSPORTER			(V 8	r - agv.	(Ves = 0
Zero-Gate-Voltage Drain Current (VDS = 10 Vdc, VGS = 0)	(Me)Gl	MMBFJ309 MMBFJ310	IDSS	12 24	(V 01 =	30 60	mAdc
Gate-Source Forward Voltage (IG = 1.0 mAdc, VDS = 0)	(ng)EQ1		V _{GS(f)}			1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS	Cles	V 01 = 1	Visc = 0, Vak			ponisin	ngut Capac
Forward Transfer Admittance (VDS = 10 Vdc, ID = 10 mAdc, f =	1.0 kHz)	胡	Y _{fs}	8.0	t o colo nation	18	mmhos
Output Admittance $(V_{DS} = 10 \text{ Vdc}, I_{D} = 10 \text{ mAdc}, f =$	1.0 kHz)		Yos	-		250	μmhos
Input Capacitance $(V_{GS} = -10 \text{ Vdc}, V_{DS} = 0 \text{ Vdc}, f = 0 \text{ Vdc})$	= 1.0 MHz)		C _{iss}	-		5.0	pF
Reverse Transfer Capacitance $(V_{GS} = -10 \text{ Vdc}, V_{DS} = 0 \text{ Vdc}, f = 0 \text{ Vdc})$	= 1.0 MHz)		C _{rss}	-	_	2.5	pF
Equivalent Short-Circuit Input Noise V (VDS = 10 Vdc, ID = 10 mAdc, f =			ē _n		10		nV/√Hz

Note: "LT1" must be used when ordering SOT-23 devices.

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	25	Vdc
Gate-Source Voltage	VGS	25	Vdc
Gate Current WOG MURGAM	IG	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	TJ, Tstq	-55 to +150	°C

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBFU310LT1 = 6C

MMBFU310LT1*

SEMICONPUCTOR TECHNICAL DATA

CASE 318-07, STYLE 10 SOT-23 (TO-236AB)





JFET TRANSISTOR

N-CHANNEL

★This is a Motorola designated preferred device.

Refer to J310 for graphs.

FI FCTRICAL	CHARACTERISTICS (7	Γ _Λ =	25°C unless	otherwise	noted)

Ch	aracteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	STAD TOUR HILL	OUDPURE FOR	the original than the	1 1. (- 1 1 1.)	950
Gate-Source Breakdown Voltage (IG = $-1.0 \mu A$, VDS = 0)	BDURGE :	V(BR)GSS	- 25	_	Vdc
Gate 1 Leakage Current (VGS = -15 V, VDS = 0)	noted) Symbol	I _{G1SS}	0,98=91)	- 150	pA
Gate 2 Leakage Current (VGS = -15 V, VDS = 0, TA = 125		I _{G2SS}		- 150	nA
Gate Source Cutoff Voltage (V _{DS} = 10 V, I _D = 1.0 nA)	Stork	VGS(off)	-2.5	-6.0	Vdc
ON CHARACTERISTICS	g ^q	(1)0	S = AT A	oltages no	Total Pa
Zero-Gate-Voltage Drain Current (VDS = 10 V, VGS = 0)	nteT .i. I	IDSS	24	60	mA
Gate-Source Forward Voltage (IG = 10 mA, VDS = 0)		V _{GS(f)}	_	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					10119
Forward Transfer Admittance (VDS = 10 V, ID = 10 mA, f = 1.0 l	kHz)	Y _{fs}	10	18	mmhos
Output Admittance $(V_{DS} = 10 \text{ V}, I_{D} = 10 \text{ mA}, f = 1.0 \text{ I})$	kHz)	Yos	map of lot	250	μmhos
Input Capacitance (VGS = -10 V, VDS = 10 V, f = 1.	using minimure recommendate feetprint. (zHM 0	C _{iss}	qe a salçılı fi	5.0	pF
Reverse Transfer Capacitance (VGS = -10 V, VDS = 10 V, f = 1.	0 MHz)	C _{rss}	_	2.5	pF

Medium Power Field Effect Transistor

N-Channel Enhancement-Mode Silicon Gate TMOS SOT-223 for Surface Mount

This TMOS medium power field effect transistor is designed for high speed, low loss power switching applications such as switching regulators, dc-dc converters, solenoid and relay drivers. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- · Silicon Gate for Fast Switching Speeds
- RDS(on) = 14 Ohm Max
- Low Drive Requirement
- The SOT-223 Package can be Soldered Using Wave or Reflow. The Formed Leads Absorb Thermal Stress During Soldering Eliminating the Possibility of Damage to the Die.
- Available in 12 mm Tape and Reel
 Use MMFT107T1 to order the 7 inch/1000 unit reel
 Use MMFT107T3 to order the 13 inch/4000 unit reel



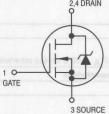
MEDIUM POWER TMOS FET 250 mA, 200 VOLTS

RDS(on) = 14 OHM MAX





CASE 318E-04, STYLE 3 TO-261AA



MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit =
Drain-to-Source Voltage	V _{DSS}	200	Volts
Gate-to-Source Voltage — Non-Repetitive	V _{GS}	±20	Volts
Drain Current	ID	250	mAdc
Total Power Dissipation @ T _A = 25°C(1) Derate above 25°C	PD	0.8 6.4	Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{stg}	-65 to 150	°C

DEVICE MARKING

FT107

THERMAL CHARACTERISTICS

Thermal Resistance — Junction to Ambient	R ₀ JA	156	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	TL (ski)	260 10	°C Sec

^{1.} Device mounted on FR-4 glass epoxy printed circuit using minimum recommended footprint.

Preferred devices are Motorola recommended choices for future use and best overall value.

4-70

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characte	ristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	員					
Drain-to-Source Breakdown Voltage (VGS = 0, ID = 10 μA)	A1-g	V _(BR) DSS	200	1-		Vdc
Zero Gate Voltage Drain Current (V _{DS} = 130 V, V _{GS} = 0)	\$ 200	IDSS		1-	30	nAdc
Gate-Body Leakage Current — Reverse (VGS = 15 Vdc, VDS = 0)	100	IGSS	-		10	nAdc
ON CHARACTERISTICS (1)						
Gate Threshold Voltage (VDS = VGS, ID = 1.0 mAdc)	000	VGS(th)	1.0		3.0	Vdc
Static Drain-to-Source On-Resistance (VGS = 10 Vdc, I _D = 200 mA)	ad pa	RDS(on)		_	14	Ohms
Drain-to-Source On-Voltage (VGS = 10 V, ID = 200 mA)	25 - 75 - 50 - 25 D	V _{DS} (on)	— 1900 (8194A) TAS	200— DRAIN CURR	2.8	Vdc
Forward Transconductance (VDS = 25 V, ID = 250 mA)	Figure 4. On-Realstan	man 9fs mient	l au al av e	300	9-mOn en	mmhos
DYNAMIC CHARACTERISTICS						
Input Capacitance	250	C _{iss}	1-1-	60	-	pF
Output Capacitance	$(V_{DS} = 25 \text{ V}, V_{GS} = 0,$ f = 1.0 MHz)	Coss	1-1	30	-	
Transfer Capacitance	7 = 25°C	C _{rss}	1-	6.0		
SOURCE DRAIN DIODE CHARACTERIS	STICS			1)		
Diode Forward Voltage	100	VF	-	0.8	_	V
Continuous Source Current, Body Diode	(V _{GS} = 0, I _S = 250 mA)	Is			250	mA
Pulsed Source Current, Body Diode		ISM		1	500	

^{1.} Pulse Test: Pulse Width \leq 300 $\mu s,$ Duty Cycle \leq 2.0%.

TYPICAL ELECTRICAL CHARACTERISTICS

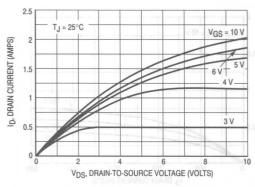


Figure 1. On-Region Characteristics

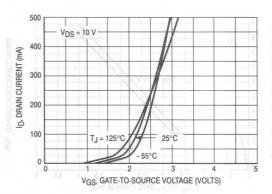


Figure 2. Transfer Characteristics

TYPICAL ELECTRICAL CHARACTERISTICS

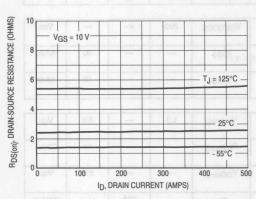


Figure 3. On-Resistance versus Drain Current

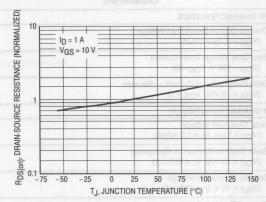


Figure 4. On-Resistance Variation with Temperature

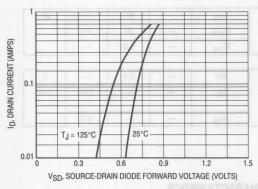


Figure 5. Source-Drain Diode Forward Voltage

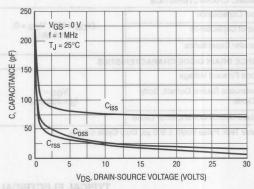


Figure 6. Capacitance Variation

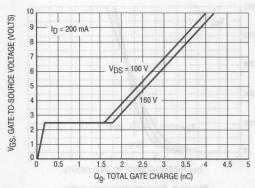


Figure 7. Gate Charge versus Gate-to-Source Voltage

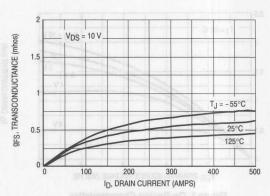


Figure 8. Transconductance

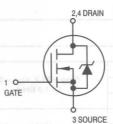
Medium Power Field Effect Transistor

N-Channel Enhancement-Mode Silicon Gate TMOS SOT-223 for Surface Mount

This TMOS medium power field effect transistor is designed for high speed, low loss power switching applications such as switching regulators, dc-dc converters, solenoid and relay drivers. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- Silicon Gate for Fast Switching Speeds
- RDS(on) = 1.7 Ohm Max
- Low Drive Requirement
- The SOT-223 Package can be Soldered Using Wave or Reflow. The Formed Leads Absorb Thermal Stress During Soldering Eliminating the Possibility of Damage to the Die.
- Available in 12 mm Tape and Reel
 Use MMFT960T1 to order the 7 inch/1000 unit reel
 Use MMFT960T3 to order the 13 inch/4000 unit reel





MMFT960T1

Motorola Preferred Device

MEDIUM POWER
TMOS FET
300 mA
60 VOLTS

RDS(on) = 1.7 OHM MAX



CASE 318E-04, STYLE 3 TO-261AA

MAXIMUM RATINGS (TC = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Drain-to-Source Voltage	VDS	60	Volts
Gate-to-Source Voltage — Non-Repetitive	V _{GS}	±30	Volts
Drain Current	ID	300	mAdc
Total Power Dissipation @ T _A = 25°C(1) Derate above 25°C	PD PD	0.8 6.4	Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{Stg}	-65 to 150	°C

DEVICE MARKING

FT960

THERMAL CHARACTERISTICS

Thermal Resistance — Junction to Ambient	R ₀ JA	156	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	ys T _L	260 10	°C Sec

^{1.} Device mounted on a FR-4 glass epoxy printed circuit board using minimum recommended footprint.

Preferred devices are Motorola recommended choices for future use and best overall value.

MMFT960T1

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted)

Characteri	stic	Symbol	Min	Тур	Max	Unit
FF CHARACTERISTICS		15 mm 1 mm	0.00			
Drain-to-Source Breakdown Voltage (VGS = 0, I _D = 10 μA)	352	V _{(BR)DSS}	60	A AE CA	n <u>Le</u> se minimalia	Vdc
Zero Gate Voltage Drain Current (VDS = 60 V, VGS = 0)		IDSS	l-triem	ponsd	10	μAdc
Gate-Body Leakage Current (V _{GS} = 15 Vdc, V _{DS} = 0)		IGSS	nuoM	MUS urface	50	nAdc
ON CHARACTERISTICS (1)		and the state of	and the state of	atoli sassono	mails are 1	CHET HIS
Gate Threshold Voltage (V _{DS} = V _{GS} , I _D = 1.0 mAdc)	19 en c	V _{GS(th)}	1.0	a 1ewoq :	3.5	Vdc
Static Drain-to-Source On-Resistance (VGS = 10 Vdc, ID = 1.0 A)	Long Long	R _{DS} (on)	-223 -y écku spplication	n the SOT ace mount	1.7	Ohms
Drain-to-Source On-Voltage (V _{GS} = 10 V, I _D = 0.5 A) (V _{GS} = 10 V, I _D = 1.0 A)	BOMT ARUAS	V _{DS(on)}	Speeds	Switchist Max	0.8 1.7	Vdc
Forward Transconductance (V _{DS} = 25 V, I _D = 0.5 A)	K	9fs	Soldered	600	223 Pack	mmhos
DYNAMIC CHARACTERISTICS		amage to the Die.	ibility of Di	g the Pass	nitesimi3	Soldering
Input Capacitance	2-1	C _{iss}	_lsel	65	mm 41 ni	pF
Output Capacitance	$(V_{DS} = 25 \text{ V}, V_{GS} = 0,$ f = 1.0 MHz)	Coss	ideal 27 s	33	FIEDER N	Use M
Transfer Capacitance	, = 1.0 Will2)	C _{rss}	_	7.0	-	
Total Gate Charge	RIGEO	Qg	-	3.2	-	nC
Gate-Source Charge	$(V_{GS} = 10 \text{ V}, I_{D} = 1.0 \text{ A}, V_{DS} = 48 \text{ V})$	Qgs	amo esemp	1.2	GERSTIAG	MUSSIX
Gate-Drain Charge	odanya . Do . 10 v)	Q _{qd}	Bunes.	2.0		

^{1.} Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

TYPICAL ELECTRICAL CHARACTERISTICS

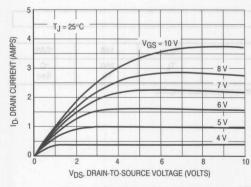


Figure 1. On-Region Characteristics

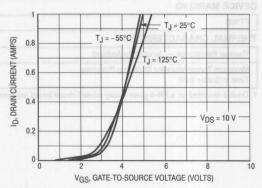


Figure 2. Transfer Characteristics

TYPICAL ELECTRICAL CHARACTERISTICS

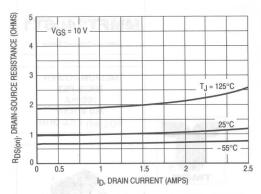


Figure 3. On-Resistance versus Drain Current

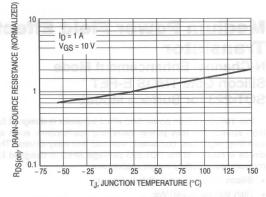


Figure 4. On-Resistance Variation with Temperature

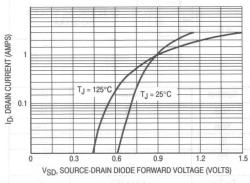


Figure 5. Source-Drain Diode Forward Voltage

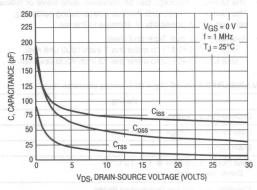


Figure 6. Capacitance Variation

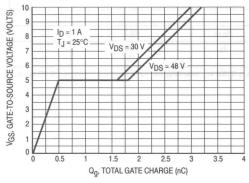


Figure 7. Gate Charge versus Gate-to-Source Voltage

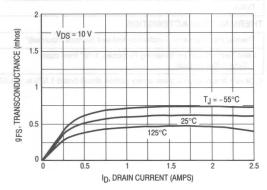


Figure 8. Transconductance

Medium Power Field Effect Transistor

N-Channel Enhancement Mode Silicon Gate TMOS E-FET™ SOT-223 for Surface Mount

This TMOS medium power field effect transistor is designed for high speed, low loss power switching applications such as switching regulators, converters, solenoid and relay drivers. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- · Silicon Gate for Fast Switching Speeds
- High Voltage 240 Vdc
- · Low Drive Requirement
- The SOT-223 Package can be soldered using wave or reflow.
 The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die.
- Available in 12 mm Tape and Reel
 Use MMFT2406T1 to order the 7 inch/1000 unit reel.

 Use MMFT2406T3 to order the 13 inch/4000 unit reel.

MMFT2406T1

Motorola Preferred Device

MEDIUM POWER
TMOS FET
700 mA
240 VOLTS
RDS(on) = 6.0 OHM







CASE 318E-04, STYLE 3 TO-261AA

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Drain-to-Source Voltage	VDS	240	Vdc
Gate-to-Source Voltage — Continuous	VGS	±20	Vdc
Drain Current	ID	700	mAdc
Total Power Dissipation @ T _A = 25°C*(1) Derate above 25°C	a.i PD s.i	1.5 12	Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{sta}	-65 to 150	°C

DEVICE MARKING

T2406

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)*	R ₀ JA	83.3	°C/W
Lead Temperature for Soldering Purposes, 1/16" from case	TL	260	°C
Time in Solder Bath		10	Sec

1. Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 sq. in.

Preferred devices are Motorola recommended choices for future use and best overall value.

Charac	teristics	Symbol	Min	Max	Unit
OFF CHARACTERISTICS		AD-100 A - 10 - 1		-700	21.8
Drain-to-Source Breakdown Voltage (V _{GS} = 0, I _D = 100 μA)	100	V _{(BR)DSS}	240	wests	Vdc
Zero Gate Voltage Drain Current (VDS = 120 V, VGS = 0)		IDSS	meme	10	μAdc
Gate-Body Leakage Current (VGS = 15 Vdc, VDS = 0)		IGSS	s _ ce Mou	100	nAdc
ON CHARACTERISTICS(2)			re-to-		LICE SET
Gate Threshold Voltage (V _{DS} = V _{GS} , I _D = 1.0 mAdc)	ea doue	VGS(th)	0.8	2.0	Vdc
Static Drain-to-Source On-Resistance (V _{GS} = 2.5 Vdc, I _D = 0.1 Adc) (V _{GS} = 10 Vdc, I _D = 0.5 Adc)	lesigned	R _{DS(on)}	SOT 223 par sunt ap plicati tunc Speeds	10 6.0	Ohms
Drain-to-Source On-Voltage (VGS = 10 V, ID = 0.5 A)	MAPG ES	V _{DS(on)}	- 	3.0	Vdc
Forward Transconductance (V _{DS} = 6.0 V, I _D = 0.5 A)	wolfen	9FS	300	Paclinge car	mmhos
DYNAMIC CHARACTERISTICS		ethe die.	of agement to	s villete son o	renerala
Input Capacitance	本一	C _{iss}	le ul fi bri	125	pF
Output Capacitance	$(V_{DS} = 25 \text{ V}, V_{GS} = 0)$ f = 1.0 MHz)	Coss	DEF THE TRUE	50	JSE N
Transfer Capacitance	1	C _{rss}	_	20	

^{2.} Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

Medium Power Field Effect Transistor

N-Channel Enhancement-Mode Silicon Gate TMOS SOT-223 for Surface Mount

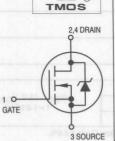
This TMOS medium power field effect transistor is designed for high speed, low loss power switching applications such as switching regulators, dc-dc converters, solenoid and relay drivers. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- Silicon Gate for Fast Switching Speeds
- RDS(on) = 4.0 Ohm Max
- Low Drive Requirement, VGS = 2.0 Volts Max
- The SOT-223 Package can be soldered using wave or reflow. The formed leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 12 mm Tape and Reel Use MMFT6661T1 to order the 7 inch/1000 unit reel Use MMFT6661T3 to order the 13 inch/4000 unit reel

MMFT6661T1

Motorola Preferred Device

MEDIUM POWER TMOS FET 500 mA 90 VOLTS RDS(on) = 4.0 OHM MAX





CASE 318E-04, STYLE 3 TO-261AA

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Drain-to-Source Voltage	V _{DS}	90	Vdc
Gate-to-Source Voltage — Non-Repetitive	V _{GS}	±30	Vdc
Drain Current	ID	500	mAdc
Total Power Dissipation @ T _A = 25°C ⁽¹⁾ Derate above 25°C	PD	0.8 6.4	Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{Stg}	-65 to 150	°C

DEVICE MARKING

T6661

THERMAL CHARACTERISTICS

Thermal Resistance — Junction to Ambient	ReJA	156	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	TL	260 10	°C Sec

^{1.} Device mounted on FR-4 glass epoxy printed circuit board using minimum recommended footprint.

Preferred devices are Motorola recommended choices for future use and best overall value

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Char	racteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	07					-
Drain-to-Source Breakdown Volta ($V_{GS} = 0$, $I_D = 10 \mu A$)	ge Ar-gl = 5	V _{(BR)DSS}	90		-	Vdc
Zero Gate Voltage Drain Current (V _{DS} = 90 V, V _{GS} = 0)		IDSS	_	_	10	μAdc
Gate-Body Leakage Current (VGS = 15 Vdc, VDS = 0)		IGSS	-		100	nAdc
ON CHARACTERISTICS (2)		0.53				
Gate Threshold Voltage (V _{DS} = V _{GS} , I _D = 1.0 mAdc)	DRO INC	VGS(th)	0.8	-	2.0	Vdc
Static Drain-to-Source On-Resista (V _{GS} = 10 Vdc, I _D = 1.0 Adc)	ance	R _{DS(on)}			4.0	Ohms
Drain-to-Source On-Voltage (VGS = 10 V, I _D = 1.0 A) (VGS = 5.0 V, I _D = 0.3 A)		V _{DS(on)}	everiments	DRAIN CURR	4.0 1.6	Vdc
Forward Transconductance (V _{DS} = 25 V, I _D = 0.5 A)	OFF	9FS	_	200	_	mmhos
DYNAMIC CHARACTERISTICS						
Input Capacitance	4.08	C _{iss}	_	36	_	pF
Output Capacitance	(V _{DS} = 25 V, V _{GS} = 0, f = 1.0 MHz)	Coss	-	16	-	
Transfer Capacitance	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	C _{rss}		6.0	_	
Total Gate Charge		Qg	-	1.7	1_	nC
Gate-Source Charge	(V _{GS} = 10 V, I _D = 1.0 A, V _{DS} = 72 V)	Qgs	3	0.34	1-	
Gate-Drain Charge	108	Q _{qd}	-	0.23		

Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

TYPICAL ELECTRICAL CHARACTERISTICS

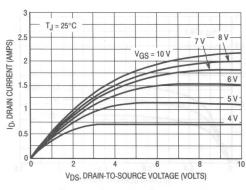


Figure 1. On-Region Characteristics

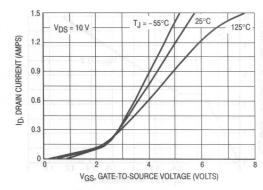


Figure 2. Transfer Characteristics

TYPICAL ELECTRICAL CHARACTERISTICS

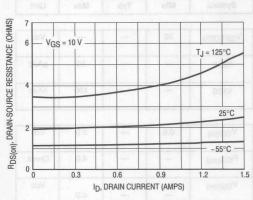


Figure 3. On-Resistance versus Drain Current

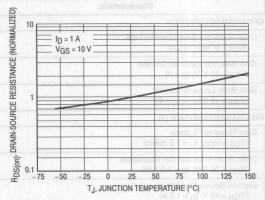


Figure 4. On-Resistance Variation with Temperature

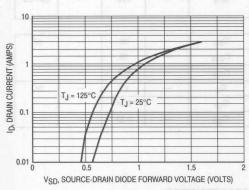


Figure 5. Source-Drain Diode Forward Voltage

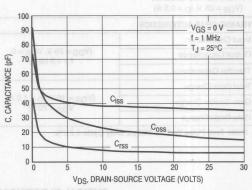


Figure 6. Capacitance versus Drain-Source Voltage

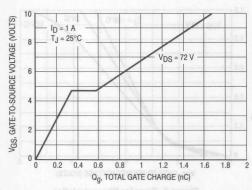


Figure 7. Gate Charge versus Gate-to-Source Voltage

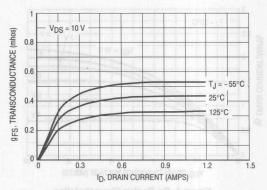
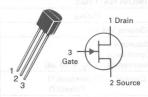


Figure 8. Transconductance

MPF102

CASE 29-04, STYLE 5 TO-92 (TO-226AA)



JFET VHF AMPLIFIER

N-CHANNEL — DEPLETION

Refer to 2N5484 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	ob A 25	Vdc
Drain-Gate Voltage	V _{DG}	25	Vdc
Gate-Source Voltage	VGS	- 25	Vdc
Gate Current	IG	10	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW/°C
Junction Temperature Range	TJ	125	°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS			Barragatta	TABLASIA P
Gate-Source Breakdown Voltage (IG = -10μ Adc, VDS = 0)	V(BR)GSS	- 25	ou. Fain C	Vdc
Gate Reverse Current (V _{GS} = -15 Vdc, V _{DS} = 0) (V _{GS} = -15 Vdc, V _{DS} = 0, T _A = 100°C)	IGSS	=	-2.0 -2.0	nAdc μAdc
Gate Source Cutoff Voltage (Vps = 15 Vdc, Ip = 2.0 nAdc)	V _{GS(off)}	9381-0	-8.0	Vdc
Gate Source Voltage (Vps = 15 Vdc, lp = 0.2 mAdc)	VGS	-0.5	-7.5	Vdc
ON CHARACTERISTICS		(A)	Maria Caris	DA - SOM
Zero-Gate-Voltage Drain Current* (Vps = 15 Vdc, V _{GS} = 0 Vdc)	IDSS	2.0	20	mAdc
SMALL-SIGNAL CHARACTERISTICS		A/	OF HIS OF I	Stu state
Forward Transfer Admittance* (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 kHz) (V _{DS} = 15 Vdc, V _{GS} = 0, f = 100 MHz)	yfs	2000 1600	7500	μmhos
Input Admittance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 100 MHz)	Re(y _{is})	-	800	μmhos
Output Conductance $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 100 \text{ MHz})$	Re(y _{OS})	_	200	μmhos
Input Capacitance ($V_{DS} = 15 \text{ Vdc}$, $V_{GS} = 0$, $f = 1.0 \text{ MHz}$)	C _{iss}	_	7.0	pF
Reverse Transfer Capacitance (Vps = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)	C _{rss}	_	3.0	pF

^{*}Pulse Test: Pulse Width ≤ 630 ms; Duty Cycle ≤ 10%.

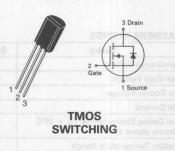
Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	60	Vdc
Gate-Source Voltage — Continuous — Non-repetitive (t _p ≤ 50 μs)	V _{GS} V _{GSM}	±20 ±40	Vdc Vpk
Drain Current — Continuous(1) Pulsed(2)	I _D	0.5 1.0	Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C MPF910	PD	1.0 8.0	Watts mW/°C
Total Device Dissipation @ T _C = 25°C Derate above 25°C MFE910	PD	6.25 50	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-65 to +150	°C

(1) The Power Dissipation of the package may result in a lower continuous drain current.

(2) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPF910

MPF910 CASE 29-05, STYLE 22 TO-92 (TO-226AE)



N-CHANNEL — ENHANCEMENT

Refer to MPF6659 for graphs.

acteristic	Symbol	Min	Тур	Max	Unit
			8	30 81/213	ARAHO W
SSD(BB)V	I _{DSS}	_	0.1	10	μAdc
3331	I _{GSS}		0.01	10	nAdc
(HolSDV	V(BR)DSS	60	90	eV HoteQ	Vdc
			Television Inc.		py //
50	VGS(th)	0.3	1.5	2.5	Vdc
ead!	V _{DS(on)}	_	n Current*	2.5	Vdc
	I _{D(on)}	500	HEIRETOA	NAL CHAF	mA
IVESI	9fs	100	**************************************	nster Adm 5 Vds, Vgs	mmhos
	888 ¹ (ha)25 ^V 50 ^V	IDSS	IDSS	IDSS	IDSS

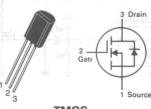
Rating	Symbol	MPF930	MPF960	MPF990	Unit
Drain-Source Voltage	V _{DS}	35	60	90	Vdc
Drain-Gate Voltage	V _{DG}	35	60	90	Vdc
Gate-Source Voltage — Continuous — Non-repetitive (t _p ≤ 50 μs)	V _{GS} V _{GSM}	nec issue	± 20 ± 40	Ţţ	Vdc Vpk
Drain Current Continuous (1) Pulsed (2)	I _D	nevni	2.0 3.0		Adc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	ndul	1.0 8.0		Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	PAU	-55 to 15	0	°C
Thermal Resistance	θ_{JA}		125	1000	°C/W

(1) The Power Dissipation of the package may result in a lower continuous drain current.

(2) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPF930* MPF960* MPF990*

CASE 29-05, STYLE 22 TO-92 (TO-226AE)



TMOS SWITCHING

N-CHANNEL — ENHANCEMENT

★These are Motorola designated preferred devices.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	- to 5 - E					
Drain-Source Breakdown Voltage (VGS = 0, ID = 10 μ A)	MPF930 MPF960 MPF990	V _{(BR)DSX}	35 60 90		=	Vdc
Gate Reverse Current (VGS = 15 Vdc, VDS = 0)	0	IGSS	-1-1		50	nAdc
ON CHARACTERISTICS*	U 091	CS: 697 68	\$4 GF	97 ns-	5) - 50,-	65
Zero-Gate-Voltage Drain Current (VDS = Maximum Rat	ting, V _{GS} = 0)	IDSS	U LANGENATU	MOTOMOU.	10	μAdc
Gate Threshold Voltage (I _D = 1.0 mA, V _{DS} = V _{GS})		V _{GS(Th)}	1.0	_	3.5	Vdc
Drain-Source On-Voltage (VGS = 10 V) (ID = 0.5 A) (ID = 1.0 A) (ID = 2.0 A)	MPF930 MPF960 MPF990 MPF930 MPF960 MPF990 MPF930 MPF960	V _D S(on)	NH2-79*1	0.4 0.6 0.6 0.9 1.2 1.2 2.2 2.8	0.7 0.8 1.2 1.4 1.7 2.4 3.0 3.5	Vdc
Static Drain-Source On Resistance (VGS = 10 Vdc, ID = 1.0 Adc)	MPF990 MPF930 MPF960	rDS(on)	7	0.9	1.4	Ohms
0.5	MPF990	-		1.2	1.7 2.0	E.0
On-State Drain Current (VDS = 25 V, VGS = 10 V)		ID(on)	1.0	2.0		Amps
SMALL-SIGNAL CHARACTERISTICS	0 01	2.0 8.0 9.0	5,0 8.0	3.0 4,0	0.1	9
Input Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MHz	:)	Ciss	DATEDY 338	70		pF
Reverse Transfer Capacitance (V _{DS} = 25 V, V _{GS} = 0,	f = 1.0 MHz)	C _{rss}	_	20	_	pF
Output Capacitance $(V_{DS} = 25 \text{ V}, V_{GS} = 0, f = 1.0 \text{ M})$	Hz)	Coss		49	_	pF
Forward Transconductance $(V_{DS} = 25 \text{ V}, I_{D} = 0.5 \text{ A})$		9fs	200	380	_	mmhos
SWITCHING CHARACTERISTICS						
Turn-On Time		ton	_	7.0	15	ns
Turn-Off Time		toff	_	7.0	15	ns

*Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

Rev 1

RESISTIVE SWITCHING

FIGURE 1 - SWITCHING TEST CIRCUIT

FIGURE 2 — SWITCHING WAVEFORMS

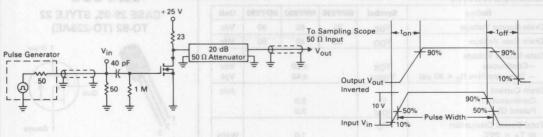
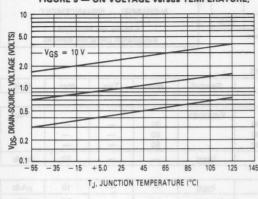


FIGURE 3 - ON VOLTAGE versus TEMPERATURE.

FIGURE 4 — CAPACITANCE VARIATION



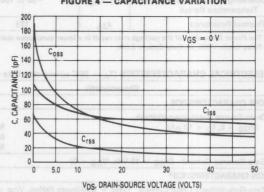
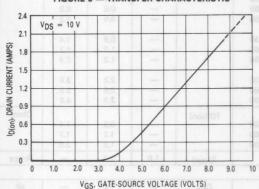
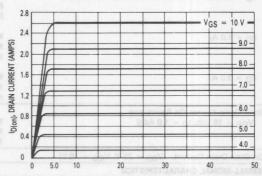


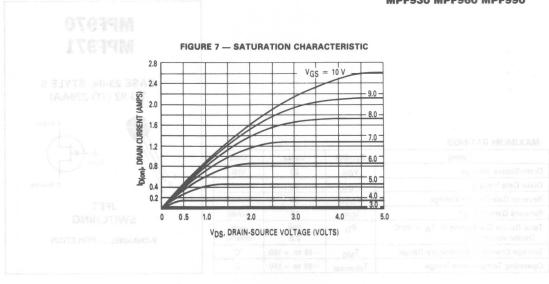
FIGURE 5 - TRANSFER CHARACTERISTIC

FIGURE 6 - OUTPUT CHARACTERISTIC



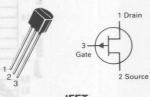


MPF930 MPF960 MPF990



MPF970 MPF971

CASE 29-04, STYLE 5 TO-92 (TO-226AA)



JFET SWITCHING

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	25	Vdc
Drain-Gate Voltage	V _{DG}	30	Vdc
Reverse Gate-Source Voltage	VGSR	30	Vdc
Forward Gate Current	lG(f)	10	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Storage Channel Temperature Range	T _{stg}	-65 to +150	°C
Operating Temperature Range	T _{channel}	-65 to +150	°C

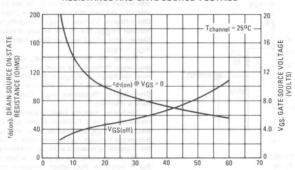
Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS			T. T.			
Gate-Source Breakdown Voltage (IG = 1.0 μ Adc, VDS = 0)		V(BR)GSS	30	_	_	Vdc
Gate Reverse Current $(V_{GS} = 15 \text{ Vdc}, V_{DS} = 0)$ $(V_{GS} = 15 \text{ Vdc}, V_{DS} = 0, T_A = 150^{\circ}\text{C})$		IGSS	1=	=	1.0 1.0	nAdc μAdc
$\begin{array}{lll} Drain-Cutoff Current & & & \\ (V_{DS} = 15 \ Vdc, \ V_{GS} = 12 \ Vdc) & & \\ (V_{DS} = 15 \ Vdc, \ V_{GS} = 12 \ Vdc, \ T_{A} = 150 ^{\circ}C) & & \\ (V_{DS} = 15 \ Vdc, \ V_{GS} = 7.0 \ Vdc) & & \\ (V_{DS} = 15 \ Vdc, \ V_{GS} = 7.0 \ Vdc, \ T_{A} = 150 ^{\circ}C) & & \\ \end{array}$	MPF970 MPF970 MPF971 MPF971	^I D(off)		=	10 10 10 10	nAdc μAdc nAdc μAdc
Gate Source Cutoff Voltage $(V_{DS} = 15 \text{ Vdc}, I_D = 10 \text{ nAdc})$	MPF970 MPF971	VGS(off)	5.0 1.0	=	12 7.0	Vdc
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current(1) (VDS = 20 Vdc, VGS = 0)	MPF970 MPF971	DSS	- 15 - 2.0	=	- 100 - 50	mAdc
Drain-Source On-Voltage (I _D = 10 mAdc, V _{GS} = 0) (I _D = 1.5 mAdc, V _{GS} = 0)		V _{DS(on)}	=	=	1.5 1.5	Vdc
Static Drain-Source On Resistance (ID = 1.0 mAdc, $V_{GS} = 0$)	MPF970 MPF971	rDS(on)	_	_	100 250	Ohms
SMALL-SIGNAL CHARACTERISTICS						
Drain-Source "ON" Resistance $(V_{GS} = 0, I_{D} = 0, f = 1.0 \text{ kHz})$	MPF970 MPF971	^r ds(on)	=	=	100 250	Ohms
Input Capacitance (VGS = 12 Vdc, VDS = 0, f = 1.0 MHz) (VGS = 7.0 Vdc, VDS = 0, f = 1.0 MHz)	MPF970 MPF971	C _{iss}	_	_	12 12	pF
Reverse Transfer Capacitance (VGS = 12 Vdc, VDS = 0, f = 1.0 MHz) (VGS = 7.0 Vdc, VDS = 0, f = 1.0 MHz)	MPF970 MPF971	C _{rss}	=	_	5.0 5.0	pF

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

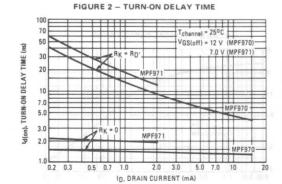
Characteristic		Symbol	Min	Тур	Max	Unit			
SWITCHING CHARACTERISTICS (See Figure 6, R _K = 0) (1)									
Rise Time $(ID_{On}) = 10 \text{ mAdc}, V_{GS_{Off}}) = 12 \text{ Vdc})$ $(ID_{On}) = 1.5 \text{ mAdc}, V_{GS_{Off}}) = 7.0 \text{ Vdc})$	MPF970 MPF971	(CERNIT _F O. 7		2.0 3.0	5.0 5.0	ns			
Fall Time $(I_{D(on)} = 10 \text{ mAdc}, V_{GS(off)} = 12 \text{ Vdc})$ $(I_{D(on)} = 1.5 \text{ mAdc}, V_{GS(off)} = 7.0 \text{ Vdc})$	MPF970 MPF971	tf		9.0 68	15 80	ns			
Turn-On Time	MPF970 MPF971	ton		3.5 5.0	8.0 10	ns			
Turn-Off Time $(ID_{On}) = 10 \text{ mAdc}, V_{GS(off)} = 12 \text{ Vdc})$ $(ID_{On}) = 1.5 \text{ mAdc}, V_{GS(off)} = 7.0 \text{ Vdc})$	MPF970 MPF971	toff		13 88	25 120	ns			

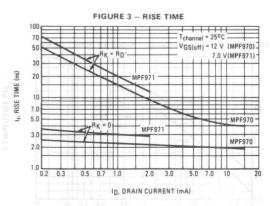
⁽¹⁾ Pulse Test: Pulse Width \leq 100 μ s, Duty Cycle \leq 1.0%.





IDSS, ZERO-GATE VOLTAGE DRAIN CURRENT (mA)





MPF970 MPF971

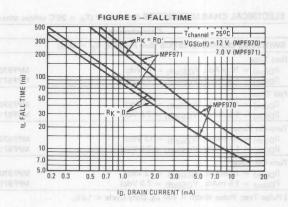
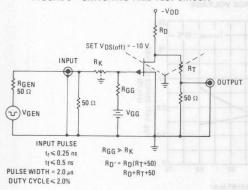


FIGURE 6 - SWITCHING TIME TEST CIRCUIT



NOTE

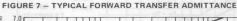
The switching characteristics shown above were measured using a test circuit similar to Figure 6. At the beginning of the switching interval, the gate voltage is at Gate Supply Voltage (+VGG). The Drain-Source Voltage (VDS) is slightly lower than Drain Supply Voltage (VDD) due to the voltage divider. Thus Reverse Transfer Capacitance (C_{rss}) or Gate-Drain Capacitance (C_{gd}) is charged to VGG+ VDS.

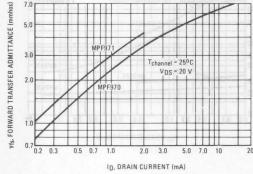
 $V_{GG} + V_{DS}$. During the turn-on interval, Gate-Source Capacitance (C_{gS}) discharges through the series combination of R_{Gen} and R_K . C_{gd} must discharge to $V_{DS(on)}$ through R_G and R_K in series with the parallel combination of effective load impedance (R'_D) and Drain-Source Resistance (r_{dS}) . During the turn-off, this charge flow is reversed

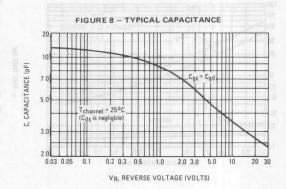
Predicting turn-on time is somewhat difficult as the channel resistance r_{ds} is a function of the gate-source voltage. While C_{gs} discharges, V_{GS} approaches zero and r_{ds} decreases. Since C_{gd} discharges through r_{ds}, turn-on time is non-linear. During turn-off, the situation is reversed with r_{ds} increasing as C_{gd} charges.

The above switching curves show two impedance conditions; 1)

The above switching curves show two impedance conditions; 1) $R_{\rm K}$ is equal to $R_{\rm D}$, which simulates the switching behavior of cascaded stages where the driving source impedance is normally the load impedance of the previous stage, and 2) $R_{\rm K}=0$ (low impedance) the driving source impedance is that of the generator.







MPF970 MPF971

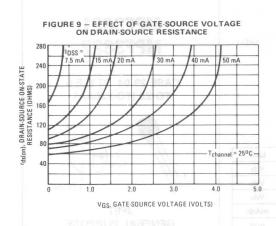


FIGURE 10 — EFFECT OF TEMPERATURE ON DRAIN-SOURCE ON-STATE RESISTANCE

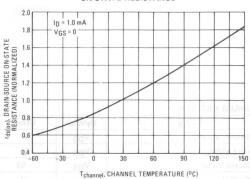
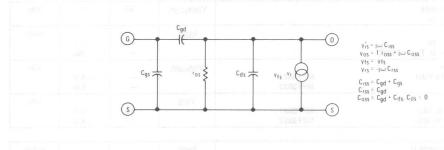
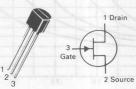


FIGURE 11 - LOW FREQUENCY CIRCUIT MODEL



MPF3821

CASE 29-04, STYLE 5 TO-92 (TO-226AA)



GENERAL PURPOSE

Unit

Vdc

Vdc

Vdc

mAdc

mW

mW/°C

°C

°C

JFET

N-CHANNEL — DEPLETION

Refer to 2N5457 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Symbol

VDS

VDG

VGS

ID

 P_{D}

TJ

Tstg

Value

50

50

- 50

10

350

2.8

125

65 to 150

MAXIMUM RATINGS

Drain-Source Voltage

Drain-Gate Voltage

Drain Current

Gate-Source Voltage

Derate above 25°C

Junction Temperature Range

Storage Temperature Range

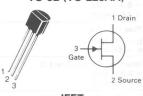
Total Device Dissipation (a T_A = 25°C

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS	NEOUENCY CIRCUIT	THE BRIDE IT - LC			
Gate-Source Breakdown Voltage $(I_G = -1.0 \mu Adc, V_{DS} = 0)$		V _(BR) GSS	- 50	_	Vdc
Gate Reverse Current $(V_{GS} = -30 \text{ Vdc}, V_{DS} = 0)$ $(V_{GS} = -30 \text{ Vdc}, V_{DS} = 0, T_A = 150^{\circ}\text{C})$	011	IGSS	-0	- 0.1 - 100	nAdc
Gate Source Cutoff Voltage (ID = 0.5 nAdc, VDS = 15 Vdc)	MPF3821 MPF3822	VGS(off)	E 492	- 4.0 - 6.0	Vdc
Gate Source Voltage (ID = 50 μ Adc, VDS = 15 Vdc) (ID = 200 μ Adc, VDS = 15 Vdc)	MPF3821 MPF3822	V _{GS}	- 0.5 - 1.0	- 2.0 - 4.0	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current(1) $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0)$	MPF3821 MPF3822	IDSS	0.5 2.0	2.5 10	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 1.0 \text{ kHz})(1)$	MPF3821 MPF3822	Yfs	1500 3000	4500 6500	μmhos
$(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 100 \text{ MHz})$	MPF3821 MPF3822		1500 3000	Ξ	
Output Admittance(1) $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 1.0 \text{ kHz})$	MPF3821 MPF3822	Yos	_	10 20	μmhos
Input Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)		C _{iss}	-	6.0	pF
Reverse Transfer Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz)		C _{rss}		3.0	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure ($V_{DS}=15~Vdc, V_{GS}=0, R_{S}=1.0~megohm, f=10~Hz, Noise Bandwidth=5.0~Hz)$		NF	-	5.0	dB
Equivalent Input Noise Voltage (VDS = 15 Vdc, VGS = 0, f = 10 Hz, Noise Bandw	vidth = 5.0 Hz)	e _n		200	nv/Hz ¹ /

⁽¹⁾ Pulse Test: Pulse Width ≤ 100 ms, Duty Cycle ≤ 10%.

MPF4392* MPF4393*

CASE 29-04, STYLE 5 TO-92 (TO-226AA)



JFETs SWITCHING

N-CHANNEL — DEPLETION

★MPF4392 and MPF4393 are Motorola designated preferred devices.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DS}	30	Vdc
Drain-Gate Voltage	V _{DG}	30	Vdc
Gate-Source Voltage	VGS	30	Vdc
Forward Gate Current	I _{G(f)}	50	mAdc
Total Device Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Operating and Storage Channel Temperature Range	T _{channel} ,	-65 to +150	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

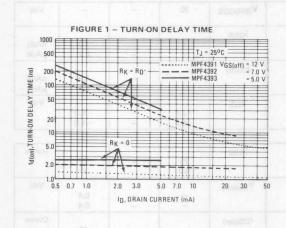
Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	CHARACTERIST	MI SMILITHING	SINAL	•		
Gate-Source Breakdown Voltage (I _G = 1.0 μ Adc, V _{DS} = 0)		V _(BR) GSS	30	-	-	Vdc
Gate Reverse Current $(V_{GS}=15\ V_{dC},V_{DS}=0)$ $(V_{GS}=15\ V_{dC},V_{DS}=0,T_{A}=100^{\circ}C)$	CO2	IGSS	MIT YAJAU	NO WAUT -	1.0 0.2	nAdc μAdc
Drain Cutoff Current (VDS = 15 Vdc, VGS = 12 Vdc) (VDS = 15 Vdc, VGS = 12 Vdc, $T_A = 100^{\circ}C$)	005	ID(off)	p 79/4 p 79/4 p 21/4 =	1 1	1.0 0.1	nAdc μAdc
Gate Source Voltage (V _{DS} = 15 Vdc, I _D = 10 nAdc)	MPF4392 MPF4393	V _{GS}	-2.0 -0.5		-5.0 -3.0	Vdc
ON CHARACTERISTICS	Library I					EW #
Zero-Gate-Voltage Drain Current(1) $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0)$	MPF4392 MPF4393	IDSS	25 5.0		75 30	mAdc
Drain-Source On-Voltage ($I_D=6.0 \text{ mAdc}, V_{GS}=0$) ($I_D=3.0 \text{ mAdc}, V_{GS}=0$)	MPF4392 MPF4393	V _{DS(on)}	0. 7.8 VO.	10. 9 TAILE	0.4 0.4	Vdc
Static Drain-Source On Resistance ($I_D=1.0 \text{ mAdc}, V_{GS}=0$)	MPF4392 MPF4393	rDS(on)			60 100	Ohms
SMALL-SIGNAL CHARACTERISTICS	000					
Forward Transfer Admittance (Vps = 15 Vdc, Ip = 25 mAdc, f = 1.0 kHz) (Vps = 15 Vdc, Ip = 5.0 mAdc, f = 1.0 kHz)	MPF4392 MPF4393	Vfs	1000	17 12	-	mmhos
Drain-Source "ON" Resistance (VGS = 0, I _D = 0, f = 1.0 kHz)	MPF4392 MPF4393	rds(on)			60 100	Ohms
Input Capacitance (VGS = 15 Vdc, VDS = 0, f = 1.0 MHz)	101, 101 301, 301	C _{iss}		6.0	10	pF

MPF4392 MPF4393

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Тур	Max	Unit
Reverse Transfer Capacitance (VGS = 12 Vdc, VDS = 0, f = 1.0 MHz) (VDS = 15 Vdc, ID = 10 mAdc, f = 1.0 MHz)		C _{rss}	=	2.5 3.2	3.5	pF
SWITCHING CHARACTERISTICS						
Rise Time (See Figure 2) (I _{D(on)} = 6.0 mAdc) (I _{D(on)} = 3.0 mAdc)	MPF4392 MPF4393	t _r	_	2.0 2.5	5.0 5.0	ns
Fall Time (See Figure 4) (VGS(off) = 7.0 Vdc) (VGS(off) = 5.0 Vdc)	MPF4392 MPF4393	tf	Legys-	15 29	20 35	ns
Turn-On Time (See Figures 1 and 2) (ID(on) = 6.0 mAdc) (ID(on) = 3.0 mAdc)	MPF4392 MPF4393	68 ^t on	vov I	4.0 6.5	15 15	enuns me
Turn-Off Time (See Figures 3 and 4) (VGS(off) = 7.0 Vdc) (VGS(off) = 5.0 Vdc)	MPF4392 MPF4393	toff	(HO) -	20 37	35 55	ns

TYPICAL SWITCHING CHARACTERISTICS



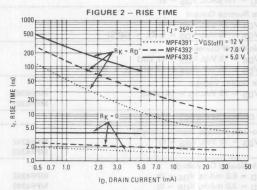
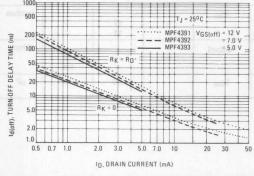


FIGURE 3 – TURN-OFF DELAY TIME



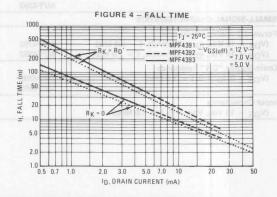
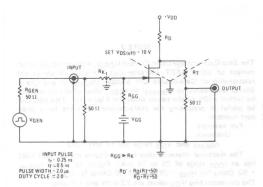


FIGURE 5 - SWITCHING TIME TEST CIRCUIT



NOTE 1

The switching characteristics shown above were measured using a test circuit similar to Figure 5. At the beginning of the switching interval, the gate voltage is at Gate Supply Voltage ($-V_{GG}$). The Drain-Source Voltage (V_{DS}) is slightly lower than Drain Supply, Voltage (V_{DD}) due to the voltage divider. Thus Reverse Transfer Capacitance (C_{rss}) or Gate-Drain Capacitance (C_{gd}) is charged to V_{GG} + V_{DS} .

During the turn-on interval, Gate-Source Capacitance (C_{gs}) discharges through the series combination of R_{Gen} and R_K . C_{gd} must discharge to $V_{DS(on)}$ through R_{G} and R_{K} in series with the parallel combination of effective load impedance (R'_{D}) and Drain-Source Resistance (r_{ds}). During the turn-off, this charge flow is reversed.

Predicting turn-on time is somewhat difficult as the channel resistance r_{ds} is a function of the gate-source voltage. While C_{gs} discharges, V_{GS} approaches zero and r_{ds} decreases. Since C_{gd} discharges through r_{ds} , turn-on time is non-linear. During turn-off, the situation is reversed with r_{ds} increasing as C_{gd} charges.

The above switching curves show two impedance conditions; 1) $R_{\rm K}$ is equal to $R_{\rm D'}$ which simulates the switching behavior of cascaded stages where the driving source impedance is normally the load impedance of the previous stage, and 2) $R_{\rm K}=0$ (low impedance) the driving source impedance is that of the generator.

FIGURE 6 - TYPICAL FORWARD TRANSFER ADMITTANCE

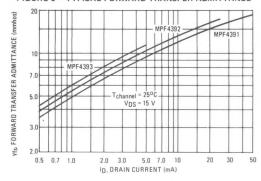


FIGURE 7 - TYPICAL CAPACITANCE

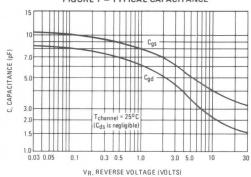


FIGURE 8 — EFFECT OF GATE-SOURCE VOLTAGE ON DRAIN-SOURCE RESISTANCE

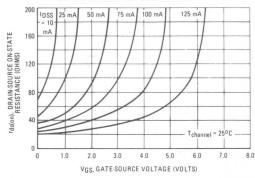


FIGURE 9 - EFFECT OF TEMPERATURE ON DRAIN-SOURCE ON-STATE RESISTANCE

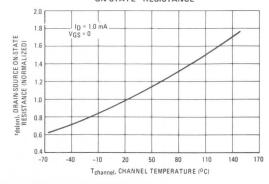
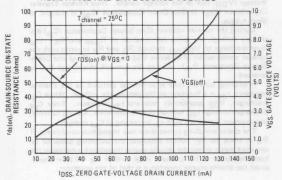


FIGURE 10 – EFFECT OF IDSS ON DRAIN-SOURCE RESISTANCE AND GATE-SOURCE VOLTAGE



NOTE 2

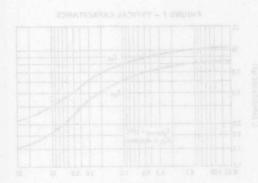
The Zero-Gate-Voltage Drain Current (IDSS), is the principle determinant of other J-FET characteristics. Figure 10 shows the relationship of Gate-Source Off Voltage (VGS(off)) and Drain-Source On Resistance (rGs(on)) to IDSS. Most of the devices will be within $\pm 10\%$ of the values shown in Figure 10. This data will be useful in predicting the characteristic variations for a given part number.

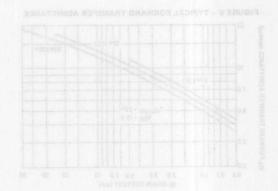
For example:

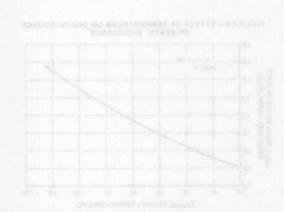
Unknown

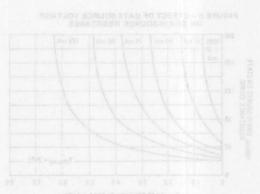
rds(on) and VGS range for an MPF4392

The electrical characteristics table indicates that an MPF4392 has an IDSS range of 25 to 75 mA. Figure 10, shows <code>rds(on) = 52 Ohms for IDSS = 25 mA</code> and 30 Ohms for IDSS = 75 mA. The corresponding V_{GS} values are 2.2 volts and 4.8 volts.



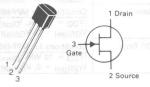






MPF4856 thru MPF4861*

CASE 29-04, STYLE 5 TO-92 (TO-226AA)



JFET SWITCHING

N-CHANNEL — DEPLETION

★These are Motorola preferred devices.

Refer to MPF4391 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MPF4856 MPF4857 MPF4858	MPF4859 MPF4860 MPF4861	Unit
Drain-Source Voltage	V _{DS}	+ 40	+ 30	Vdc
Drain-Gate Voltage	V _{DG}	+40 +30		Vdc
Reverse Gate-Source Voltage	VGSR	- 40	-30	Vdc
Forward Gate Current	IGF	50		mAdc
Total Device Dissipation (α T _A = 25°C Derate above 25°C	PD	360 2.4		mW mW/°C
Storage Temperature Range	T _{stg}	- 65 to	o + 150	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage $(I_G = 1.0 \ \mu Adc, V_{DS} = 0)$ MPF4856, MPF4857, MPF4858 MPF4859, MPF4860, MPF4861	V(BR)GSS	- 40 - 30	_	Vdc
Gate Reverse Current	IGSS	=	0.25 0.25 0.5 0.5	nAdc μAdc
Gate Source Cutoff Voltage (V _{DS} = 15 Vdc, I _D = 0.5 nAdc) MPF4856, MPF4859 MPF4857, MPF4860 MPF4858, MPF4861	VGS(off)	-4.0 -2.0 -0.8	- 10 - 6.0 - 4.0	Vdc
Drain Cutoff Current ($V_{DS}=15~V_{dC},V_{GS}=-10~V_{dC}$) ($V_{DS}=15~V_{dC},V_{GS}=-10~V_{dC},T_{A}=150^{\circ}C$)	ID(off)	_	0.25 0.5	nAdc μAdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current(1) (V _{DS} = 15 Vdc, V _{GS} = 0) MPF4856, MPF4859 MPF4857, MPF4860 MPF4858, MPF4861	IDSS	50 20 8.0	 100 80	mAdc
Drain-Source On-Voltage (ID = 20 mAdc, VGS = 0) MPF4856, MPF4859 (ID = 10 mAdc, VGS = 0) MPF4857, MPF4860 (ID = 5.0 mAdc, VGS = 0) MPF4858, MPF4861	VDS(on)	=	0.75 0.5 0.5	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Drain-Source "ON" Resistance (VGS = 0, I _D = 0, f = 1.0 kHz) MPF4856, MPF4859 MPF4857, MPF4860 MPF4858, MPF4861	^r ds(on)	=	25 40 60	Ohms
Input Capacitance $(V_{DS} = 0, V_{GS} = -10 \text{ Vdc}, f = 1.0 \text{ MHz})$ MPF4856 thru MPF4861	C _{iss}	_	18	pF
Reverse Transfer Capacitance (VDS = 0, VGS = -10 Vdc, f = 1.0 MHz) MPF4856 thru MPF4861	C _{rss}	_	8.0	pF

	Characteristic				Min	Max	Unit
SWITCHING CHA	ARACTERISTICS	y age				HA THA	
Turn-On Delay Time	Conditions for MPF4856, N (VDD = 10 Vdc, I _{D(on)} = VGS(on) = 0, VGS(off) =	20 mAdc,	O mAdc, MPF4857, MPF4860 10 Vdc) MPF4858, MPF4861 PF4860: MPF4856, MPF4859 O mAdc, MPF4857, MPF4860		=	6.0 6.0 10	ns
Rise Time	Conditions for MPF4857, N (VDD = 10 Vdc, ID(on) = VGS(on) = 0, VGS(off) =	10 mAdc,			=	3.0 4.0 10	ns
Turn-Off Time	Conditions for MPF4858, N (V _{DD} = 10 Vdc, I _{D(on)} = V _{GS(on)} = 0, V _{GS(off)} =	5.0 mAdc,	MPF4856, MP MPF4857, MP MPF4858, MP	F4860	=	25 50 100	ns eaun-Source
8 90000e s		abV .	05+ 08+	∂G ^V		ottage	train-Care V
	N-CHAMNEL — DEPL						

MPF466D, MPF486D		

Rating	Symbol	MPF6659	MPF6660	MPF6661	Unit
Drain-Source Voltage	V _{DS}	35	60	90	Vdc
Drain-Gate Voltage	V _{DG}	35	60	90	Vdc
Gate-Source Voltage - Continuous - Non-repetitive (t _p ≤ 50 μs)	V _{GS} V _{GSM}	nol Tipi	± 20 ± 40		Vdc Vpk
Drain Current Continuous (1) Pulsed (2)	I _D		2.0 3.0		Adc
Total Device Dissipation @ T _C = 25°C Derate above 25°C	PD		2.5	ive svi	Watts mW/°C
Total Device Dissipation @ T _A = 25°C Derate above 25°C	P _D	FIE	1.0 8.0	TIVORE	Watts mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	−55 to +150			°C

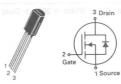
⁽¹⁾ The Power Dissipation of the package may result in a lower continuous drain current.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

(2) Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MPF6659 thru MPF6661*

CASE 29-05, STYLE 22 TO-92 (TO-226AE)



TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

★MPF6660 and MPF6661 are Motorola designated preferred devices.

Characteristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						
Zero-Gate-Voltage Drain Current (V _{DS} = Maximum Rating, V _{GS} = 0)	/ negat	IDSS	_	_	10	μAdc
Gate-Body Leakage Current (VGS = 15 V, VDS = 0)	4 38USH	IGSS	ewy GBSU	en) NOBMA	100	nAdc
Drain-Source Breakdown Voltage (V _{GS} = 0, I _D = 10 μA)	MPF6659	V(BR)DSX	35	_	_	Vdc
	MPF6660	anV = ani	60	-		

1111110001	To Armalda e sa				3 4 15
1 2 -					2
71 28	V _{GS} (Th)	0.8	1.4	2.0	Vdc
	V _{DS(on)}				Vdc
MPF6659		_	-	1.8	8.0. 1
MPF6660				3.0	- 5
MPF6661			-	4.0	40 8
MPF6659		_	0.8	1.5	
MPF6660			0.9	1.5	-10
MPF6661	100	- 0è	0.9	1.6	02-
	rDS(on)		Ulturación (Ohms
MPF6659	(,	_	_	1.8	
MPF6660		_		3.0	
MPF6661	emeride	CHARACT	Data -	4.0	
201	ID(on)	1.0	2.0	_	Amps
	-,011/				1000
	MPF6659 MPF6660 MPF6661 MPF6659 MPF6660 MPF6659 MPF6660	WPF6659 MPF6660 MPF6661 MPF6660 MPF6661 MPF6660 MPF6660 MPF6669 MPF6660	MPF6659 MPF6660 MPF6660 MPF6661 MPF6659 MPF6660 MPF6661 MPF6660 MPF6660 MPF6660 MPF6660 MPF6661	VGS(Th) 0.8 1.4 MPF6659 — — MPF6660 — — MPF6661 — — MPF6660 — 0.9 MPF6661 — 0.9 MPF6660 — 0.9 MPF6661 — — MPF6660 — — MPF6661 — —	MPF6659 MPF6661 MPF6659 MPF6660 MPF6660 MPF6660 MPF6660 MPF6660 MPF6661 MPF6660 MPF6661 MPF6659 MPF6660

$(V_{DS} = 25 \text{ V}, V_{GS} = 10 \text{ V})$	V 07	SSA				
SMALL-SIGNAL CHARACTERISTICS	1/10.20					
Input Capacitance (V _{DS} = 25 V, V _{GS} = 0, f = 1.0 MHz)	Vel	C _{iss}	-	30		pF
Reverse Transfer Capacitance (Vps = 25 V, Vgs = 0, f = 1.0 MHz)	VON	C _{rss}	-	3.6	-	pF
Output Capacitance (Vps = 25 V, Vgs = 0, f = 1.0 MHz)	V 0.8	Coss	_	20	/	pF
Forward Transconductance (Vps = 25 V, lp = 0.5 A)	-kos-	9fs	170	-	/	mmhos

Rev 1

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Characteristic				Symbol	Min	Тур	Max	Unit
SWITCHING CHARACTERISTICS(1)	Sint	virfess)	quairte	St ecapitate	Symbol		Poting	
Rise Time	Vde	-00	08	-t _r	20 Y	_	5.0	ns
Fall Time			08	tf	no V	_	5.0	ns
Turn-On Time				ton	- 1	_	5.0	ns
Turn-Off Time			=20	toff	SaA	_	5.0	ns

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

RESISTIVE SWITCHING

FIGURE 1 — SWITCHING TEST CIRCUIT FIGURE 2 — SWITCHING WAVEFORMS To Sampling Scope - toff -23 Ω 50 Ω Input Pulse Generator 9 40 pF Output Vout \$50 Ω \$ 1.0 MΩ Inverted 90% 10 V 50% 50% Pulse

FIGURE 3 — V_{GS(th)} NORMALIZED versus TEMPERATURE

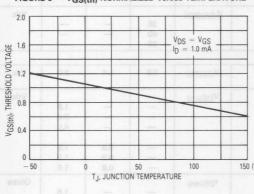


FIGURE 4 — ON-REGION CHARACTERISTICS

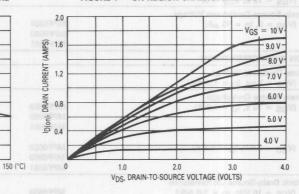


FIGURE 5 — OUTPUT CHARACTERISTICS

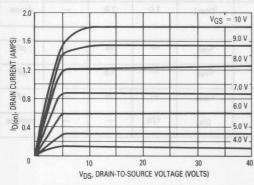
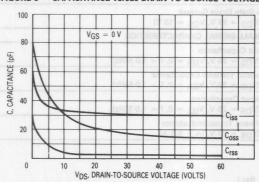
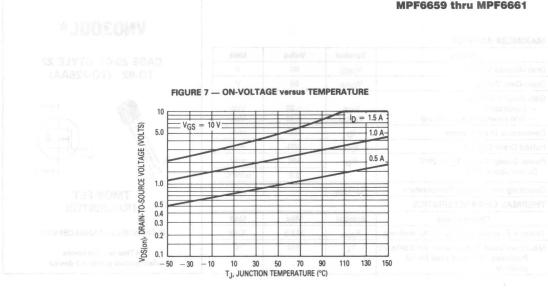


FIGURE 6 — CAPACITANCE versus DRAIN-TO-SOURCE VOLTAGE



MPF6659 thru MPF6661



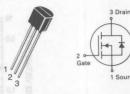
Rating	Symbol	Value	Unit
Drain-Source Voltage	VDSS	60	V
Drain-Gate Voltage	VDGR	60	V
Gate-Source Voltage — Continuous — Non-repetitive (t _p ≤ 50 µs)	V _{GS} V _{GSM}	± 20 ± 40	Vdc Vpk
Continuous Drain Current	A ID	200	mA
Pulsed Drain Current	IDM	500	mA
Power Dissipation @ T _C = 25°C	PD	350	mW
Derate above 25°C		2.8	mW/°C
Operating and Storage Temperature	TJ, T _{stg}		°C

THERMAL CHARACTERISTICS

THE MINE OF ATTACKED TOO			
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	312.5	°C/W
Maximum Lead Temperature for Soldering Purposes, 1/1e" from case for 10 seconds	T _L	300	°C

VN0300L*

CASE 29-04, STYLE 22 TO-92 (TO-226AA)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit	
STATIC CHARACTERISTICS						
Drain-Source Breakdown Voltage (VGS = 0, ID = 10 μA)		V _(BR) DSS	30	_	٧	
Zero Gate Voltage Drain Current (V _{DS} = 48 V, V _{GS} = 0) (V _{DS} = 48 V, V _{GS} = 0, T _A = 12	5 °C)	I _{DSS}	=	10 500	μΑ	
Gate-Body Leakage $(V_{DS} = 0, V_{GS} = \pm 30 \text{ V})$		IGSS		±100	nA	
Gate Threshold Voltage (VDS = VGS, ID = 1.0 mA)		V _{GS(th)}	0.8	2.5	V	
On-State Drain Current* (VDS = VGS, ID = 1.0 mA)	ate Drain Current*		1.0	-	А	
Drain-Source On Resistance* (V _G S = 5.0 V, I _D = 0.3 A) (V _G S = 10 V, I _D = 1.0 A)		rDS(on)	Ξ	3.3 1.2	Ω	
Forward Transconductance* (V _{DS} = 10 V, I _D = 0.5 A)	ansconductance*		200	-	mS	
DYNAMIC CHARACTERISTICS						
Input Capacitance		C _{iss}		100		
Output Capacitance	$V_{DS} = 15 \text{ V, } V_{GS} = 0$ f = 1.0 MHz	Coss	_	95	pF	
Reverse Transfer Capacitance	1 - 1.0 10112	C _{rss}	_	25		
SWITCHING CHARACTERISTICS						
Turn-On Time	V _{DD} = 25 V, I _D = 1.0 A	ton	_	30		
Turn-Off Time	$R_L = 24 \Omega$, $RG = 25 \Omega$	toff	7	30	ns	

^{*} Pulse Test; Pulse width < 300 $\mu\mathrm{s}$, Duty Cycle \leq 2%

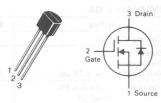
Rating	Symbol	Value	Unit
Drain-Source Voltage 30.49 33.40	V _{DSS}	60	Vdc
Drain-Gate Voltage (RGS = 1 M Ω)	VDGR	60	Vdc
Gate-Source Voltage — Continuous — Non-repetitive (t _p ≤ 50 μs)	V _{GS}	± 20 ± 40	Vdc Vpk
Drain Current Continuous Pulsed	I _D	190 1000	mAdc
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PD	3.2 400	mW/°C
Operating and Storage Temperature Range	T _J , T _{stg}	-55 to +150	€.0 °C

THERMAL CHARACTERISTICS

THE HIVE OFFICE OF THE FIELD OF						
Characteristic	Symbol	Max	Unit			
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	312.5	°C/W			
Maximum Lead Temperature for Soldering Purposes, 1/1e" from case for 10 seconds	TL	300	°C			

VN0610LL*

CASE 29-04, STYLE 22 TO-92 (TO-226AA)



TMOS FET **TRANSISTOR**

N-CHANNEL — ENHANCEMENT **★This is a Motorola** designated preferred device.

Refer to BS170 for graphs.

The U Kaliff By Cha	aracteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					25 to 15	LOARAHD 1
Drain-Source Breakdown Voltage $(V_{GS} = 0, I_D = 100 \mu A)$			V _{(BR)DSS}	60	A maye lle i jiri Janjino	Vdc 0 20V
Zero Gate Voltage Drain Current (VDS = 48 V, VGS = 0) (VDS = 48 V, VGS = 0, TJ = 125°C))	2201	IDSS	Inemi	10 500	μAdc
Gate-Body Leakage Current, Forward (VGSF = 30 Vdc, VDS = 0)			IGSSF	- 1	- 100	nAdc
ON CHARACTERISTICS*		600			0 . 1	vas abv
Gate Threshold Voltage (VDS = VGS	s, I _D = 1.0 m	A)	V _{GS(th)}	0.8	2.5	Vdc
Static Drain-Source On-Resistance (VGS = 10 Vdc, I_D = 500 mA) (VGS = 10 Vdc, I_D = 500 mA, T_C =	125°C)	нпар ^V	rDS(on)	(A)	5.0 9.0	Ohm
Drain-Source On-Voltage ($V_{GS} = 5.0 \text{ V, } I_D = 200 \text{ mA}$) ($V_{GS} = 10 \text{ V, } I_D = 500 \text{ mA}$)		siQ .	V _{DS(on)}	(V	1.5 2.5	Vdc
On-State Drain Current $(V_{GS} = 10 \text{ V})$, V _{DS} ≥ 2.0 \	DS(on)	I _{D(on)}	750	MOVE I	mA
Forward Transconductance ($V_{DS} \ge 2.0$	VDS(on), ID	= 500 mA)	9fs	100	00 - 1	μmhos
DYNAMIC CHARACTERISTICS						
Input Capacitance			Ciss	[An	60	pF
Output Capacitance	(V	$f_{DS} = 25 \text{ V, V}_{GS} = 0$ f = 1.0 MHz	Coss	_ 0	25	in-Sottrac .
Reverse Transfer Capacitance			C _{rss}	_	5.0	e 89
SWITCHING CHARACTERISTICS*		,(108fort),		The state of the s	100	() () = 2:3\
Turn-On Delay Time	(VD	D = 15 V, ID = 600 mA	ton	-	10	ns
Turn-Off Delay Time		25 ohms, R _L = 23 ohms)	toff	SHM-D-C	10	ds agv

^{*}Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

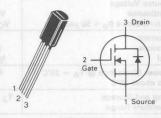
Rating	Symbol	Value	Unit
Drain-Source Voltage	VDSS	60	Vdc
Gate-Source Voltage — Continuous — Non-repetitive (t _p ≤ 50 μs)	V _{GS} V _{GSM}	± 20 ± 40	Vdc Vpk
Drain Current — Continuous (1) — Pulsed (2)	I _D	0.3 der - 1.0	Adc
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PD	1.0 8.0	Watts mW/°C
Operating and Storage Temperature Range	T _J , T _{stg}	-40 to +150	°C

(1) The Power Dissipation of the package may result in a lower continuous drain current.

(2) Pulse Width \leq 300 μ s, Duty Cycle.

VN10LM

CASE 29-05, STYLE 22 TO-92 (TO-226AE)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Characte	eristic		Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						SOFTERIST	DARAHO F
Drain-Source Breakdown Voltage (VGS = 0, I _D = 100 μA)	- Sacisal A		V(BR)DSS	60	Volta <u>ce</u>	Braskriown D = 100 pu	Vdc
Zero Gate Voltage Drain Current (VDS = 45 V, VGS = 0)	SSOI		IDSS		0.1	10	μAdc
Gate-Body Leakage Current (VGS = -15 V, VDS = 0)	lasse		IGSS ¹		nt, Forward	100	nAdc
Gate-Body Leakage Current (VGS = 15 V, VDS = 0)			lGSS ²		_ (0 =	-100	nAdc
ON CHARACTERISTICS	Vesimi		(A	mid t = gl	ray = eavi	egs/loV bi	orisenti ett
Gate Threshold Voltage (VDS = VGS, ID = 1.0 mA)	TDS(on)		VGS(th)	0.8	esiste <u>m</u> e Od mAl	2.5	Vdc
On-State Drain Current (VDS = 15 V, VGS = 10 V)	VDS(on)		I _{D(on)}	750	31 Ann 30	On-Voltage	mA
Forward Transconductance (VDS = 15 V, ID = 500 mA)			9fs	200	(Am	008 = 01 N	mmhos
Drain-Source On-Voltage (VGS = 5.0 V, I _D = 200 mA)	(en) (dig		VDS(on) ¹	Application is	1408 = 18 V 24 IVgs = 2	1.5	Vdc
Drain-Source On-Voltage (VGS = 10 V, ID = 500 mA)			V _{DS(on)} ²	-	1108	2.5	Vdc
Drain-Source On-Resistance (VGS = 5.0 V, I _D = 200 mA)	Count	0 - 8	rDS(on) ¹	4 -	-	7.5	Ω
Drain-Source On-Resistance (VGS = 10 V, I _D = 500 mA)	2219		rDS(on) ²		1800081	5.0	Ω
Input Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MH	z) sal	Am 000 = 20 onms)	Ciss	IGV)	-	60	pF
Output Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MH	z)		Coss	/ Cyc le = 2.0	300 Jac, Out	25	1 pF eal
Reverse Transfer Capacitance (VDS = 25 V, VGS = 0 V, f = 1.0 N	1Hz)		C _{rss}	-	-	5.0	pF
Turn-On Time $(V_{DS} = 15 \text{ V}, R_L = 23 \Omega, R_G = 50)$	Ω, V _{in} = 20 V)		ton	13-5	-	10	ns
Turn-Off Time $(V_{DS} = 15 \text{ V}, R_L = 23 \Omega, R_G = 50)$	Ω , $V_{in} = 20 \text{ V}$		toff	-	-	10	ns

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DSS}	170	V
Drain-Gate Voltage	V _{DGR}	60	V
Gate-Source Voltage — Continuous —Non-repetitive (t _p ≤ 50 μs)	V _{GS} V _{GSM}	± 20 ± 40	Vdc Vpk
Continuous Drain Current	ID	200	mA
Pulsed Drain Current	IDM	500	mA
Power Dissipation @ T _C = 25°C	PD	350	mW
Derate above 25°C		2.8	mW/°C
Operating and Storage Temperature	T _J , T _{sta}	0.001	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	312.5	°C/W
Maximum Lead Temperature for Soldering Purposes, 1/16" from case for 10 seconds	TL	300	°C

VN1706L*

CASE 29-04, STYLE 22 TO-92 (TO-226AA)





TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

★This is a Motoroladesignated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Cha	racteristic	Symbol	Min	Max	Unit
STATIC CHARACTERISTICS	T			001 1 101	protected to
Drain-Source Breakdown Voltage $(V_{GS} = 0, I_D = 100 \mu A)$	SSTREET	V _{(BR)DSS}	170	Auto— on	V
Zero Gate Voltage Drain Current (VDS = 120 V, VGS = 0) (VDS = 120 V, VGS = 0, TA = 125 $^{\circ}$	C)	IDSS	1 <u>7</u> 25°C	10 500	μΑ
Gate-Body Leakage (V _{DS} = 0, V _{GS} = ±15 V)	1890	IGSS	- (0	±100	nA
Gate Threshold Voltage (V _{DS} = V _{GS} , I _D = 1.0 mA)	(Hugap V	VGS(th)	0.8	2.0	V tolerand
On-State Drain Current* $(V_{GS} = 10 \text{ V, } V_{DS} \ge 2.0 \text{ V}_{DS(on)})$	InotStr	I _{D(on)}	1.0	0 15 my	A
Drain-Source On Resistance* ($V_{GS} = 2.5 \text{ V}$, $I_D = 0.1 \text{ A}$) ($V_{GS} = 10 \text{ V}$, $I_D = 0.5 \text{ A}$)	Vbsian	rDS(on)	_ (A)	10 6.0	29
Forward Transconductance* (V _{DS} = 10 V, I _D = 0.5 A)		9fs	300	716 311	mS
DYNAMIC CHARACTERISTICS			THO/EUT		ne d'Election
Input Capacitance	216	C _{iss}	- JAH	125	Vos - 10
Output Capacitance	$V_{DS} = 25 \text{ V}, V_{GS} = 0$ f = 1.0 MHz	Coss	- 800	50	pF
Reverse Transfer Capacitance	1 - 1.0 Will2	C _{rss}	_	20	riosmed for
SWITCHING CHARACTERISTICS	= 25 V, V5 S = 0	80,4		9157	Light Burea
0.8	ma-2	t(on)	- 0.50	8.0	nist i gamok
Turn-On Time	V _{DD} = 60 V, I _D = 0.1 A	t _r	-4 85078	8.0	100HACTTN
- 201	$R_L = 150 \Omega$, $R_G = 25 \Omega$	t(off)	_	18	ns sectino-n
Turn-Off Time	ohms, Rt = 23 ohms) Lott	t(f)	_	12	uted No-in

^{*} Pulse Test; Pulse width < 300 μ s, Duty Cycle \leq 2%

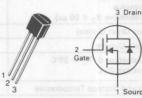
Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DSS}	60	Vdc
Drain-Gate Voltage (RGS = 1 M Ω)	VDGR	60	Vdc
Gate-Source Voltage — Continuous —Non-repetitive (t _p ≤ 50 μs)	V _{GS}	±20 ±40	Vdc Vpk
Drain Current Continuous Pulsed	IDM	150 1000	mAdc
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PD	400 3.2	mW mW/°C
Operating and Storage Temperature Range	T _J , T _{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	312.5	°C/W
Maximum Lead Temperature for Soldering Purposes, 1/16" from case for 10 seconds	TL	300	°C

VN2222LL*

CASE 29-04, STYLE 22 TO-92 (TO-226AA)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

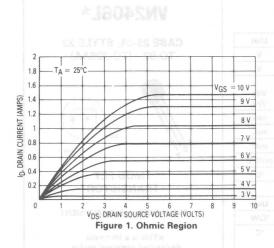
★This is a Motorola
designated preferred device.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Char	acteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	2-200/15/20				2012 125 000
Drain-Source Breakdown Voltage (VGS = 0, I _D = 100 μA)	геа(на)V	V(BR)DSS	60	V nwebinen	Vdc
Zero Gate Voltage Drain Current (VDS = 48 V, VGS = 0) (VDS = 48 V, VGS = 0, T_J = 125°C)	sad	IDSS	_1/20/11	10 500	μAdc
Gate-Body Leakage Current, Forward (VGSF = 30 Vdc, VDS = 0)	aapl	IGSSF	- A	-100	nAdc
ON CHARACTERISTICS*				1 21 2 1 65	7 W 187
Gate Threshold Voltage (VDS = VGS,	$I_D = 1.0 \text{ mA}$	VGS(th)	0.6	2.5	Vdc
Static Drain-Source On-Resistance (VGS = 10 Vdc, I_D = 0.5 Adc) (VGS = 10 Vdc, I_D = 0.5 V, T_C = 128	(HO)(O)	rDS(on)	(l <u>ab</u>)say	7.5 13.5	Ohm
Drain-Source On-Voltage (VGS = 5.0 V, I _D = 200 mA) (VGS = 10 V, I _D = 500 mA)		VDS(on)		1.5 3.75	Vdc
On-State Drain Current (VGS = 10 Vdc, V _{DS} ≥ 2.0 V _{DS(on)})	인테	I _{D(on)}	750	IA 8,0 = QL	mA
Forward Transconductance (Vps = 10 V, Ip = 500 mA)	gg/2	9fs	100	500	μmhos
DYNAMIC CHARACTERISTICS		VOS SOV		eome	at Capacit
Input Capacitance	Cint	C _{iss}	_ BC	60	pF
Output Capacitance	$(V_{DS} = 25 \text{ V}, V_{GS} = 0)$ f = 1.0 MHz)	Coss	_200	25	D DWIND
Reverse Transfer Capacitance	(40)2	C _{rss}	_	5.0	
SWITCHING CHARACTERISTICS*	A f.0 =	dt. V 98 = ggV			einit no
Turn-On Delay Time	(V _{DD} = 15 V, I _D = 600 mA	ton	-	10	ns
Turn-Off Delay Time	$R_{gen} = 25 \text{ ohms}, R_L = 23 \text{ ohms})$	toff		10	emit mo

^{*}Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

VN2222LL



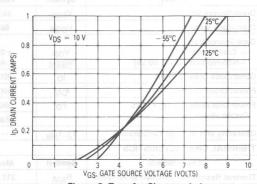
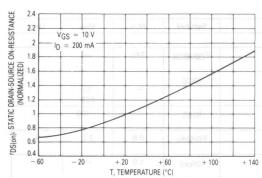


Figure 2. Transfer Characteristics



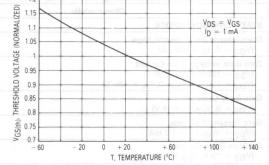


Figure 3. Temperature versus Static Drain-Source On-Resistance

Figure 4. Temperature versus Gate Threshold Voltage

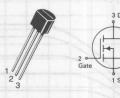
WOODWIND DATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DSS}	240	V
Drain-Gate Voltage	V _{DGR}	60	V
Gate-Source Voltage — Continuous —Non-repetitive (t _p ≤ 50 μs)	V _{GS} V _{GSM}	± 20 ± 40	Vdc Vpk
Continuous Drain Current	ID	200	mA
Pulsed Drain Current	IDM	500	mA
Power Dissipation @ T _C = 25°C	PD	350	mW
Derate above 25°C		2.8	mW/°C
Operating and Storage Temperature	TJ, Tstg	20-6-	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	312.5	°C/W
Maximum Lead Temperature for Soldering Purposes, ¼16" from case for 10 seconds	TL	300	°C

CASE 29-04, STYLE 22 TO-92 (TO-226AA)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

	Symbol	Min	Max	Unit	
STATIC CHARACTERISTICS				2 m 000 m	2 15
Drain-Source Breakdown Voltage (VGS = 0, ID = 100 μ A)	V _{(BR)DSS}	240	_	V	
Zero Gate Voltage Drain Current ($V_{DS} = 120 \text{ V}, V_{GS} = 0$) ($V_{DS} = 120 \text{ V}, V_{GS} = 0, T_A = 1$)	IDSS	-	10 500	μΑ	
Gate-Body Leakage (VDS = 0, VGS = ±15 V)	20 G	IGSS		±100	nA
(VDS = VGS ID = 1.0 mA)			0.8	2.0	V
On-State Drain Current* (VGS = 10 V, VDS \ge 2.0 VDS(on))			1.0	-14-	Α
Drain-Source On Resistance* (VGS = 2.5 V, I _D = 0.1 A) (VGS = 10 V, I _D = 0.5 A)		rDS(on)	udsev esus StelauH-aO	10 6.0	Ω
Forward Transconductance* (V _{DS} = 10 V, I _D = 0.5 A)	9fs	300	-	mS	
DYNAMIC CHARACTERISTICS					
Input Capacitance		C _{iss}	14 i <u>—</u>	125	
Output Capacitance	$V_{DS} = 25 \text{ V}, V_{GS} = 0$ f = 1.0 MHz	Coss		50	pF
Reverse Transfer Capacitance	C _{rss}	_	20		
SWITCHING CHARACTERISTICS					Veniler:
		t(on)		8.0	
Turn-On Time	V _{DD} = 60 V, I _D = 0.4 A	t _r	_	8.0	200
R _L = 150 S	$R_L = 150 \Omega, R_G = 25 \Omega$	t(off)	-	23	ns
Turn-Off Time		t _(f)	_	34	

^{*} Pulse Test; Pulse width < 300 μs , Duty Cycle \leq 2%

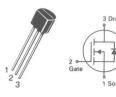
Rating	Symbol	Value	Unit
Drain-Source Voltage	V _{DSS}	240	V
Drain-Gate Voltage	V _{DGR}	60	V
Gate-Source Voltage — Continuous —Non-repetitive (t _p ≤ 50 μs)	V _{GS} V _{GSM}	± 20 ± 40	Vdc Vpk
Continuous Drain Current	ID	200	mA
Pulsed Drain Current	IDM	500	mA
Power Dissipation @ T _C = 25°C	PD	350	mW
Derate above 25°C		2.8	mW/°C
Operating and Storage Temperature	TJ, T _{stg}	_	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	312.5	°C/W
Maximum Lead Temperature for Soldering Purposes, 1/1e" from case for 10 seconds	TL	300	°C

VN2410L*

CASE 29-04, STYLE 22 TO-92 (TO-226AA)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

	Characteristic			Max	Unit
STATIC CHARACTERISTICS					
Drain-Source Breakdown Voltage (VGS = 0, I _D = 100 μA)		V _{(BR)DSS}	240	_	V
Zero Gate Voltage Drain Current (V _{DS} = 120 V, V _{GS} = 0) (V _{DS} = 120 V, V _{GS} = 0, T _A = 125 °C)		I _{DSS}	=	10 500	μΑ
Gate-Body Leakage (VDS = 0, VGS = ±15 V)		IGSS	-	±100	nA
Gate Threshold Voltage (V _{DS} = V _{GS} , I _D = 1.0 mA)		V _{GS(th)}	8.0	2.0	V
On-State Drain Current* (VGS = 10 V, VDS \geq 2.0 VDS(on))		l _{D(on)}	1.0	_	Α
Drain-Source On Resistance* (V _{GS} = 2.5 V, I _D = 0.1 A) (V _{GS} = 10 V, I _D = 0.5 A)		rDS(on)	_	10 10	Ω
Forward Transconductance* (V _{DS} = 10 V, I _D = 0.5 A)		9fs	300	_	mS
DYNAMIC CHARACTERISTICS					
Input Capacitance		C _{iss}	_	125	
Output Capacitance	$V_{DS} = 25 \text{ V}, V_{GS} = 0$ f = 1.0 MHz	Coss	_	50	pF
Reverse Transfer Capacitance		C _{rss}	_	20	
SWITCHING CHARACTERISTICS					
		t(on)	_	8.0	
Turn-On Time $V_{DD} = 60 \text{ V, } I_{D} = 0 \text{ V}$	V _{DD} = 60 V, I _D = 0.4 A	t _r	_	8.0	
T 0"T	$R_L = 150 \Omega, R_G = 25 \Omega$	t(off)	_	23	ns
Turn-Off Time	. 64.22.2	t(f)	_	34	

^{*} Pulse Test; Pulse width < 300 μ s, Duty Cycle \leq 2%

VN2410L*

CASE 29-94, STYLE 22 TO-92 (TO-228AA)



TINOS PET

N-CHANNEL — ENHANCEMENT

kThis is a Mozorola designated oraferred device.

RAXIMUM RATINGS

CHERMAL CHARACTERISTICS.

RECTRICAL CHAPACTERISTICS (TA = 25°C unless otherwise noted.)

Pulse Tests Pulse width < 350 us. Duty Cycle = 2%

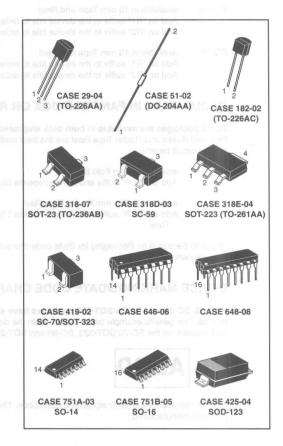
Section 5

Small-Signal Tuning and Switching Diodes

In Brief . . .

Packaging options include plastic DIPs and surface mount packages. Most SOT-23, SC-59, SC-70/SOT-323 and SOT-223 package devices are only available in Tape and Pack

NOTE: All SOT-23 package devices have had a "T1" suffix added to the device title.



EMBOSSED TAPE AND REEL

SOT-23, SC-59, SC-70/SOT-323, SOT-223, SO-14 and SO-16 packages are available in Tape and Reel. Use the appropriate suffix indicated below to order any of the SOT-23, SC-59, SC-70/SOT-323, SOT-223, SO-14 and SO-16 packages. (See Section 6 on Packaging for additional information).

SOT-23: available in 8 mm Tape and Reel

Use the device title (which already includes the "T1" suffix) to order the 7 inch/3000 unit reel.

Replace the "T1" suffix in the device title with a "T3" suffix to order the 13 inch/10.000 unit reel.

SC-59: available in 8 mm Tape and Reel

Use the device title (which already includes the "T1" suffix) to order the 7 inch/3000 unit reel. Replace the "T1" suffix in the device title with a "T3" suffix to order the 13 inch/10,000 unit reel.

SC-70/ available in 8 mm Tape and Reel

SOT-323: Use the device title (which already includes the "T1" suffix) to order the 7 inch/3000 unit reel. Replace the "T1" suffix in the device title with a "T3" suffix to order the 13 inch/10,000 unit reel.

SOT-223: available in 12 mm Tape and Reel

Use the device title (which already includes the "T1" suffix) to order the 7 inch/1000 unit reel. Replace the "T1" suffix in the device title with a "T3" suffix to order the 13 inch/4000 unit reel.

SO-14: available in 16 mm Tape and Reel

Add an "R1" suffix to the device title to order the 7 inch/500 unit reel.

Add an "R2" suffix to the device title to order the 13 inch/2500 unit reel.

SO-16: available in 16 mm Tape and Reel

Add an "R1" suffix to the device title to order the 7 inch/500 unit reel.

Add an "R2" suffix to the device title to order the 13 inch/2500 unit reel.

RADIAL TAPE IN FAN FOLD BOX OR REEL

TO-92 packages are available in both bulk shipments and in Radial Tape in Fan Fold Boxes or Reels. Fan Fold Boxes and Radial Tape Reel are the best methods for capturing devices for automatic insertion in printed circuit boards.

TO-92: available in Fan Fold Box

Add an "RLR" suffix and the appropriate Style code* to the device title to order the Fan Fold box.

available in 365 mm Radial Tape Reel

(AAISE-01) Add an "RLR" suffix and the appropriate Style code* to the device title to order the Radial Tape

*Refer to Section 6 on Packaging for Style code characters and additional information on ordering requirements.

DEVICE MARKINGS/DATE CODE CHARACTERS

SOT-23, SC-59 and SC-70/SOT-323 packages have a device marking and a date code etched on the device. The generic example below depicts both the device marking and a representation of the date code that appears on the SC-70/SOT-323, SC-59 and SOT-23 packages.



The "D" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

SILICON EPICAP DIODES

... are designed for electronic tuning and harmonic-generation applications, and provide solid-state reliability to replace mechanical tuning methods.

- Guaranteed High-Frequency Q
- Guaranteed Wide Tuning Range
- Premium 5% Capacitance Tolerance
- Standard 10% Capacitance Tolerance
- Complete Typical Design Curves

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	VR	60	Volts
Forward Current	IF.	250	mA
RF Power Input*	Pin	5.0	Watts
Device Dissipation @ T _A = 25°C Derate above 25°C	PD	400 2.67	mW mW/°C
Device Dissipation @ T _C = 25°C Derate above 25°C	PC	2.0 13.3	Watts mW/°C
Junction Temperature	TJ	+ 175	°C
Storage Temperature Range	T _{stg}	-65 to +200	°C

^{*}The RF power input rating assumes that an adequate heatsink is provided.

1N5139,A thru 1N5148,A CASE 51-02 (DO-204AA) 6.8–47 pF EPICAP VOLTAGE-VARIABLE

CAPACITANCE DIODES

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 μAdc)	V _{(BR)R}	60	70	- 1 <u>H</u> irdh	Vdc
Reverse Voltage Leakage Current (V _R = 55 Vdc, T _A = 25°C) (V _R = 55 Vdc, T _A = 150°C)	IR	- I		0.02 20	μAdc
Series Inductance (f = 250 MHz, L ≈ 1/16")	LS	-	4.0	- I	nH
Case Capacitance (f = 1.0 MHz, L ≈ 1/16")	CC		0.17	_	pF
Diode Capacitance Temperature Coefficient (V _R = 4.0 Vdc, f = 1.0 MHz)	TCC	_	200	-	ppm/°C

		C _T , Diode Capacitance V _R = 4.0 Vdc, f = 1.0 MHz pF		Q, Figure of Merit $V_R = 4.0 \text{ Vdc,}$ $f = 50 \text{ MHz}$	$V_R = 4.0 \text{ Vdc, f} = 1.0 \text{ MHz}$		TR, Tuning Ratio C ₄ /C ₆₀ f = 1.0 MHz	
Device	Min	Тур	Max	Min	Min	Тур	Min	Тур
1N5139	6.1	6.8	7.5	350	0.37	0.4	2.7	2.9
1N5139A	6.5	6.8	7.1	350	0.37	0.4	2.7	2.9
1N5140	9.0	10	11	300	0.38	0.41	2.8	3.0
1N5140A	9.5	10	10.5	300	0.38	0.41	2.8	3.0
1N5141	10.8	12	13.2	300	0.38	0.41	2.8	3.0
1N5141A	11.4	12	12.6	300	0.38	0.41	2.8	3.0
1N5142	13.5	15	16.5	250	0.38	0.41	2.8	3.0
1N5142A	14.3	15	15.7	250	0.38	0.41	2.8	3.0
1N5143	16.2	18	19.8	250	0.38	0.41	2.8	3.0
1N5143A	17.1	18	18.9	250	0.38	0.41	2.8	3.0
1N5144	19.8	22	24.2	200	0.43	0.45	3.2	3.4
1N5144A	20.9	22	23.1	200	0.43	0.45	3.2	3.4
1N5145	24.3	27	29.7	200	0.43	0.45	3.2	3.4
1N5145A	25.7	27	28.3	200	0.43	0.45	3.2	3.4
1N5146	29.7	33	36.3	200	0.43	0.45	3.2	3.4
1N5146A	31.4	33	34.6	200	0.43	0.45	3.2	3.4
1N5147	36.1	39	42.9	200	0.43	0.45	3.2	3.4
1N5147A	37.1	39	40.9	200	0.43	0.45	3.2	3.4
1N5148	42.3	47	51.7	200	0.43	0.45	3.2	3.4
1N5148A	44.7	47	49.3	200	0.43	0.45	3.2	3.4

1. LS, SERIES INDUCTANCE

LS is measured on a shorted package at 250 MHz using an impedance bridge (Boonton Radio Model 250A RX Meter). L = lead length.

2. CC, CASE CAPACITANCE

C_C is measured on an open package at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

3. C_T, DIODE CAPACITANCE

(C_T = C_C + C_J). C_T is measured at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

4. TR, TUNING RATIO

TR is the ratio of C_T measured at 4.0 Vdc divided by C_T measured at 60 Vdc.

5. Q, FIGURE OF MERIT

Q is calculated by taking the G and C readings of an admittance bridge at the specified frequency and substituting in the following equations:

$$Q = \frac{2\pi fC}{G}$$

FIGURE 1 — DIODE CAPACITANCE versus REVERSE VOLTAGE

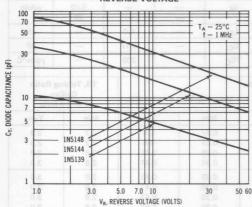
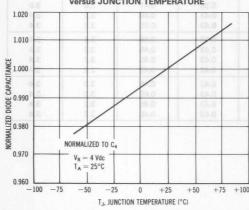


FIGURE 3 — NORMALIZED DIODE CAPACITANCE versus JUNCTION TEMPERATURE



(Boonton Electronics Model 33AS8).

6. α, DIODE CAPACITANCE REVERSE VOLTAGE SLOPE

The diode capacitance, C_T (as measured at $V_R=4.0$ Vdc, f=1.0 MHz) is compared to C_T (as measured at $V_R=60$ Vdc, f=1.0 MHz) by the following equation which defines α .

$$\alpha = \frac{\log C_{T}(4) - \log C_{T}(60)}{\log 60 - \log 4}$$

Note that a C_T versus V_R law is assumed as shown in the following equation where C_C is included.

$$C_T = \frac{K}{V\alpha}$$

7. TC_C, DIODE CAPACITANCE TEMPERATURE COEFFICIENT

TC_C is guaranteed by comparing C_T at V_R = 4.0 Vdc, f = 1.0 MHz, $T_A = -65^{\circ}\text{C}$ with C_T at V_R = 4.0 Vdc, f = 1.0 MHz, $T_A = +85^{\circ}\text{C}$ in the following equation which defines TC_C:

$$\mathsf{TC}_{C} \, = \, \left| \frac{\mathsf{C}_{T}(+85^{\circ}\mathsf{C}) \, - \, \mathsf{C}_{T}(-65^{\circ}\mathsf{C})}{85 \, + \, 65} \, \right| \, \bullet \, \frac{10^{6}}{\mathsf{C}_{T}(25^{\circ}\mathsf{C})}$$

FIGURE 2 — FIGURE OF MERIT versus REVERSE VOLTAGE

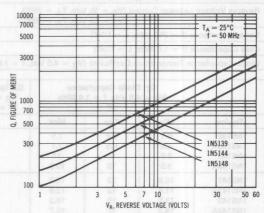
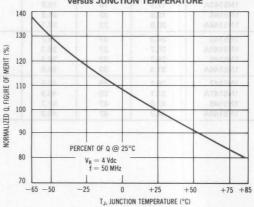
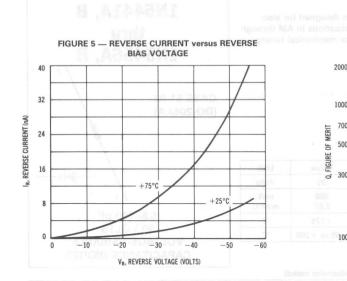
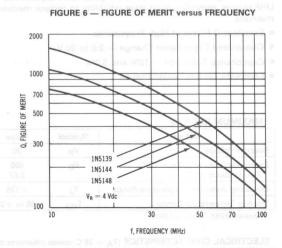


FIGURE 4 — NORMALIZED FIGURE OF MERIT VERSUS JUNCTION TEMPERATURE







A SILICON EPICAP DIODES

... epitaxial passivated abrupt junction tuning diodes designed for electronic tuning, FM, AFC and harmonic-generation applications in AM through UHF ranges, providing solid-state reliability to replace mechanical tuning

- Excellent Q Factor at High Frequencies
- Guaranteed Capacitance Change 2.0 to 30 V
- Capacitance Tolerance 10% and 5.0%
- Complete Typical Design Curves

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	VR	30	Volts
Device Dissipation @ T _A = 25°C Derate above 25°C	PD	400 2.67	mW mW/°C
Operating Junction Temperature Range	TJ	+ 175	°C
Storage Temperature Range	T _{stq}	-65 to +200	°C

^{*}Indicates JEDEC Registered Data.

1N5441A, B thru 1N5456A, B **CASE 51-02** (DO-204AA) 6.8-100 pF 30 VOLTS **VOLTAGE-VARIABLE**

CAPACITANCE DIODES

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 μAdc)	V _{(BR)R}	30	_	- 1	Vdc
Reverse Voltage Leakage Current ($V_R = 25 \text{ Vdc}$, $T_A = 25^{\circ}\text{C}$) ($V_R = 25 \text{ Vdc}$, $T_A = 150^{\circ}\text{C}$)	IR	=	=	0.02 20	μAdc
Series Inductance (f = 250 MHz, lead length $\approx 1/16"$)	LS	_	4.0	-	nH
Case Capacitance (f = 1.0 MHz, lead length \approx 1/16")	CC		0.17	_	pF
Diode Capacitance Temperature Coefficient (Note 6) (V _R = 4.0 Vdc, f = 1.0 MHz)	TCC	-	300	-	ppm/°C

Device		C _T , Diode Capacitance (1) V _R = 4.0 Vdc, f = 1.0 MHz pF			TR, Tuning Ratio C ₂ /C ₃₀ f = 1.0 MHz	
	Min (Nom – 10%)	Nom	Max (Nom +10%)	Min	Max	Min
1N5441A	6.1	6.8	7.5	2.5	3.2	450
1N5443A	9.0	10	11	2.6	3.2	400
1N5444A	10.8	12	13.2	2.6	3.2	400
1N5445A	13.5	15	16.5	2.6	3.2	400
1N5446A	16.2	18	19.8	2.6	3.2	350
1N5448A	19.8	22	24.2	2.6	3.2	350
1N5449A	24.3	27	29.7	2.6	3.2	350
1N5450A	29.7	33	36.3	2.6	3.2	350
1N5451A	35.1	39	42.9	2.6	3.2	300
1N5452A	42.3	47	51.7	2.6	3.2	250
1N5453A	50.4	56	61.6	2.6	3.3	200
1N5455A	73.8	82	90.2	2.7	3.3	175
1N5456A	90	100	110	2.7	3.3	175

⁽¹⁾ To order devices with CT Nom $\pm 5.0\%$ add Suffix B. *Indicates JEDEC Registered Data.

PARAMETER TEST METHODS

1. LS, SERIES INDUCTANCE

LS is measured on a shorted package at 250 MHz using an impedance bridge (Boonton Radio Model 250A RX Meter or equivalent).

2. CC, CASE CAPACITANCE

C_C is measured on an open package at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

3. CT, DIODE CAPACITANCE

 $(C_T = C_C + C_J)$. C_T is measured at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

4. TR, TUNING RATIO

TR is the ratio of C_T measured at 2.0 Vdc divided by C_T measured at 30 Vdc.

5. Q. FIGURE OF MERIT

Q is calculated by taking the G and C readings of an admittance bridge at the specified frequency and substituting in the following equations:

$$Q = \frac{2\pi fC}{G}$$

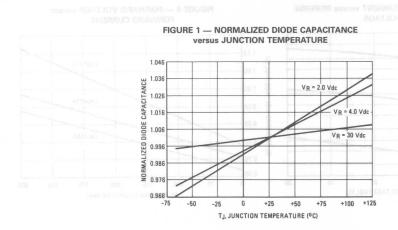
(Boonton Electronics Model 33AS8 or equivalent).

6. TCC, DIODE CAPACITANCE TEMPERATURE COEFFICIENT

TC_C is guaranteed by comparing C_T at V_R = 4.0 Vdc, f = 1.0 MHz, T_A = -65° C with C_T at V_R = 4.0 Vdc, f = 1.0 MHz, T_A = $+85^{\circ}$ C in the following equation, which defines TC_C:

$$TC_C = \begin{vmatrix} C_T(+85^{\circ}C) - C_T(-65^{\circ}C) \\ 85 + 65 \end{vmatrix} \cdot \frac{10^6}{C_T(25^{\circ}C)}$$

Accuracy limited by C_T measurement to ± 0.1 pF.



TYPICAL DEVICE PERFORMANCE

FIGURE 2 — DIODE CAPACITANCE versus REVERSE VOLTAGE

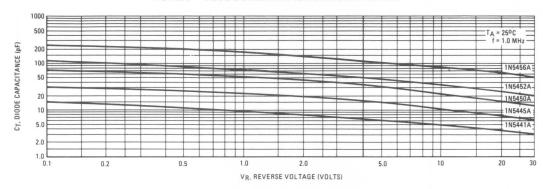


FIGURE 3 — FIGURE OF MERIT versus REVERSE VOLTAGE

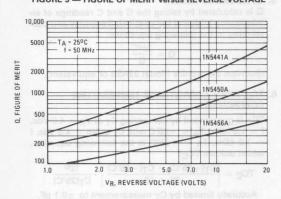


FIGURE 4 — FIGURE OF MERIT versus FREQUENCY

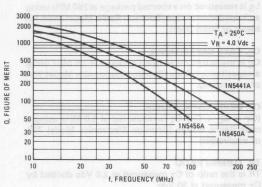


FIGURE 5 — REVERSE CURRENT versus REVERSE
BIAS VOLTAGE

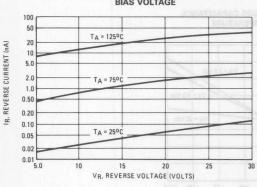
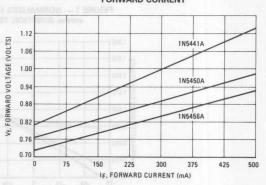


FIGURE 6 — FORWARD VOLTAGE versus FORWARD CURRENT



Silicon Pin Switching Diode

This switching diode is designed primarily for VHF band switching applications but is also suitable for use in general-purpose switching circuits. It is supplied in a SOD-123 Surface Mount package.

- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Capacitance 0.85 pF Typ at V_R = 3.0 Volts
- Very Low Series Resistance at 100 MHz 0.36 Ohms (Typ)
 @ IF = 10 mAdc
- Available in 8 mm Tape and Reel
 Use BA582T1 to order the 7 inch/3,000 unit reel
 Use BA582T3 to order the 13 inch/10,000 unit reel

1 0 2
CATHODE ANODE

BA582T1

Motorola Preferred Device



CASE 425-04, STYLE 1 SOD-123

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	VR	35	Vdc
Forward Power Dissipation @ T _A = 25°C Derate above 25°C	PF	200 2.0	mW mW/°C
Junction Temperature	O'BI - AT TJ	+125	°C
Storage Temperature Range	T _{stg}	-55 to +150	°C

DEVICE MARKING

BA582T1 = S

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 μA)	65- 68-0	V _{(BR)R}	35	8 8-	6- 0	Volts
Diode Capacitance	V _R = 1.0 V V _R = 3.0 V	CT	OUN <u>GE</u> (VO)	, RE <u>VE</u> RSE I ure 3. Dio	1.4 1.1	pF
Series Resistance (f = 100 MHz)	I _F = 3.0 mA I _F = 10 mA	RS	=	==	0.7 0.5	Ohms
Reverse Leakage Current (V _R = 20 V)		IR	_		20	nA
Forward Voltage (I _F = 100 mA)		VF	-	I T	1.0	V

Preferred devices are Motorola recommended choices for future use and best overall value.

TYPICAL ELECTRICAL CHARACTERISTICS

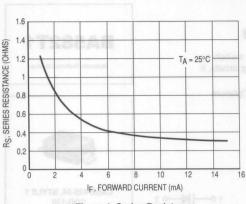


Figure 1. Series Resistance

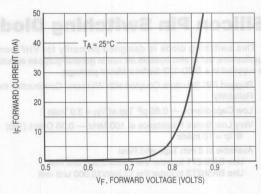


Figure 2. Forward Voltage

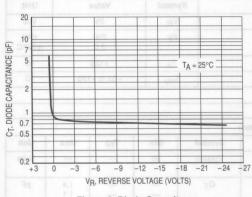


Figure 3. Diode Capacitance

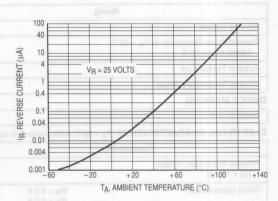


Figure 4. Leakage Current

MAXIMOM NATINGO							
Rating	Symbol	Value	Unit				
Continuous Reverse Voltage	VR	70	Vdc				
Peak Forward Current	I _F	100	mAdc				

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** TA = 25°C Derate above 25°C	PD	300 2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{sta}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BAL99LT1 = JF

BAL99LT1*

CASE 318-07, STYLE 18 SOT-23 (TO-236AB)



Anode Cathode 30 0 2

SWITCHING DIODE

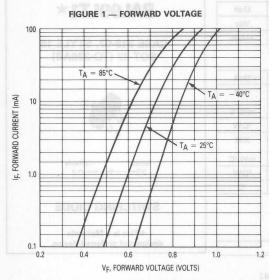
★This is a Motorola designated preferred device.

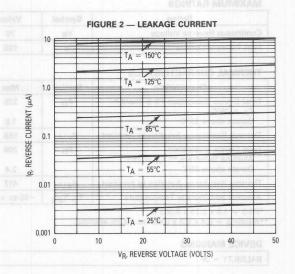
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

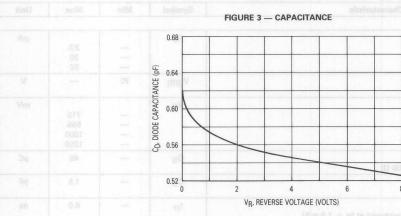
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS		Till der		
Reverse Voltage Leakage Current (V _R = 70 V) (V _R = 25 V, T _J = 150°C) (V _R = 70 V, T _J = 150°C)	I _R	Ξ	2.5 30 50	μΑ
Reverse Breakdown Voltage (I _R = 100 µA)	V _(BR)	70		٧
Forward Voltage (IF = 1.0 mA) (IF = 10 mA) (IF = 50 mA) (IF = 50 mA)	V _F , 3500	Ξ	715 855 1000 1250	mV
Recovery Current (IF = 10 mA, V_R = 5.0 V, R_L = 500 Ω)	QS		45	pC
Diode Capacitance (V _R = 0, f = 1.0 MHz)	C _D	<u>-</u>	1.5	pF
Reverse Recovery Time (IF = IR = 10 mA, RL = 100 Ω , measured at IR = 1.0 mA)	t _{rr}		6.0	ns
Forward Recovery Voltage (I _F = 10 mA, t _r = 20 ns)	VFR		1.75	٧

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

BAL99LT1







Rating	Symbol	Value	Unit
Continuous Reverse Voltage	VR	75	Vdc
Peak Forward Current	lF	200	mAdc
Peak Forward Surge Current	IFM(surge)	500	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BAS16LT1 = A6

BAS16LT1*

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)



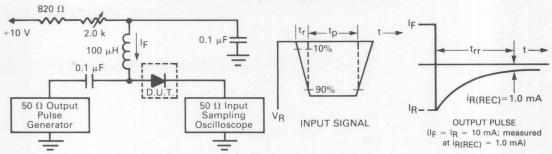
Cathode Anode

*This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Voltage Leakage Current $(V_R = 75 \text{ V})$ $(V_R = 75 \text{ V}, T_J = 150^{\circ}\text{C})$ $(V_R = 25 \text{ V}, T_J = 150^{\circ}\text{C})$	IR.	Ξ	1.0 50 30	μΑ
Reverse Breakdown Voltage (I _{BR} = 100 μA)	V(BR)	75	-	V
Forward Voltage (IF = 1.0 mA) (IF = 10 mA) (IF = 50 mA) (IF = 50 mA)	V _F	=	715 855 1000 1250	mV
Diode Capacitance (V _R = 0, f = 1.0 MHz)	C _D		2.0	pF
Forward Recovery Voltage (I _F = 10 mA, t _r = 20 ns)	VFR		1.75	V
Reverse Recovery Time (IF = IR = 10 mA, RL = 50 Ω)	Banavan trr	-	6.0	ns
Stored Charge (IF = 10 mA to VR = 5.0 V, RL = 500 Ω)	QS	-	45	pC

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 $k\Omega$ variable resistor adjusted for a Forward Current (IF) of 10 mA.

2. Input pulse is adjusted so IR(peak) is equal to 10 mA.

3. tp » trr

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.



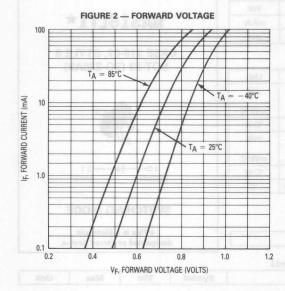
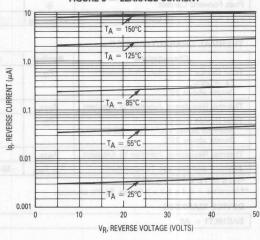
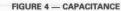
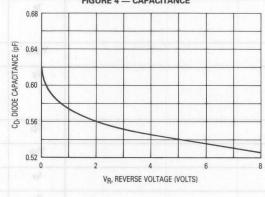


FIGURE 3 — LEAKAGE CURRENT







BAS16WT1 Motorola Preferred Device

Silicon Switching Diode

MAXIMUM RATINGS (TA = 25°C)

Rating	Symbol	Max	Unit
Continuous Reverse Voltage	VR	75	V
Recurrent Peak Forward Current	IR	200	mA
Peak Forward Surge Current Pulse Width = 10 μs	I _{FM(surge)}	500	mA
Total Power Dissipation, One Diode Loaded TA = 25°C Derate above 25°C Mounted on a Ceramic Substrate (10 x 8 x 0.6 mm)	PD	200	mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg}	-55 to +150	°C



DEVICE MARKING

A6

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient One Diode Loaded Mounted on a Ceramic Substrate (10 x 8 x 0.6 mm)	R _θ JA	0.625	°C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

	Characteristic	Symbol	Min	Max	Unit
Forward Voltage	IF = 1.0 mA IF = 10 mA IF = 50 mA IF = 100 mA	VF	= .	715 866 1000 1250	mV
Reverse Current	V _R = 75 V V _R = 75 V, T _J = 150°C V _R = 25 V, T _J = 150°C	I _R	Ξ	1.0 50 30	μА
Capacitance	V _R = 0, f = 1.0 MHz	CD	-	2.0	pF
Reverse Recovery Time I _F = I _R = 10 mA, R _L =		t _{rr}	-	6.0	ns
Stored Charge I _F = 10 mA to V _R = 6.	0 V, R _L = 500 Ω (Figure 2)	QS	- 120 ms	45	PC
Forward Recovery Volta I _F = 10 mA, t _r = 20 ns		V _{FR}	-	1.75	V

Preferred devices are Motorola recommended choices for future use and best overall value.

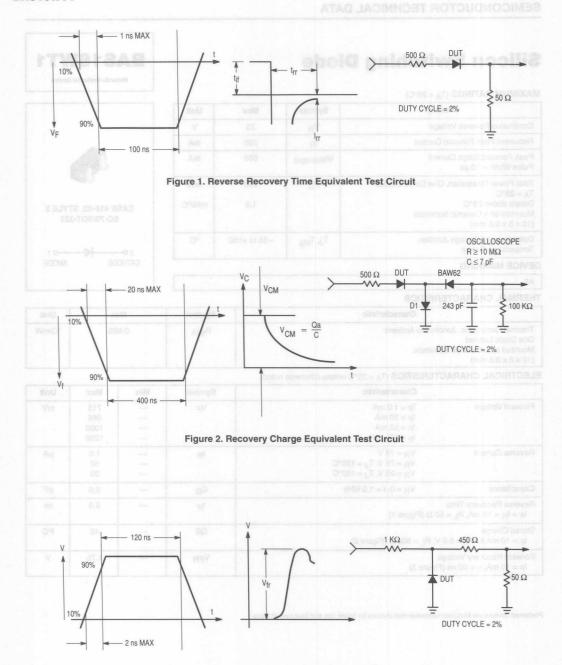
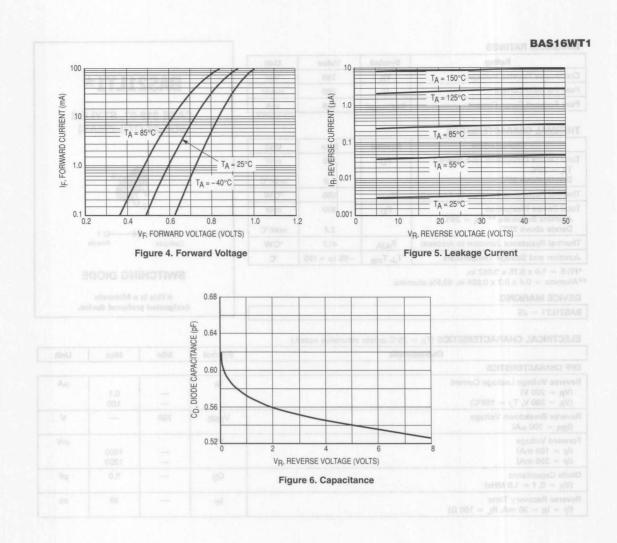


Figure 3. Forward Recovery Voltage Equivalent Test Circuit



Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V _R	250	Vdc
Peak Forward Current	lF	200	mAdc
Peak Forward Surge Current	IFM(surge)	625	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stq}	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BAS21LT1 = JS

BAS21LT1*

CASE 318-07, STYLE 8 SOT-23 (TO)-236AB)



30-Cathode Anode

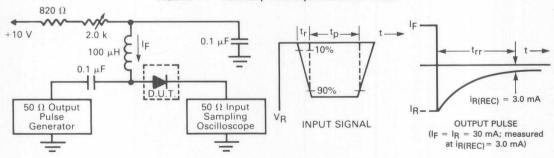
SWITCHING DIODE

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	/ca.o	ō		
Reverse Voltage Leakage Current (V _R = 200 V) (V _R = 200 V, T _J = 150°C)	İR	=	0.1 100	μΑ
Reverse Breakdown Voltage (I _{BR} = 100 μA)	V _(BR)	250	-	٧
Forward Voltage (I _F = 100 mA) (I _F = 200 mA)	VF 0	_	1000 1250	mV
Diode Capacitance (V _R = 0, f = 1.0 MHz)	CD Figure 5. Capacitan	-	5.0	pF
Reverse Recovery Time (I _F = I _R = 30 mA, R _L = 100 Ω)	t _{rr}	-	50	ns

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (IF) of 30 mA. 2. Input pulse is adjusted so IR(peak) is equal to 30 mA.

3. tp » trr

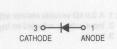
^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Switching Diode

This switching diode has the following features:

- Low Leakage Current Applications
- Medium Speed Switching Times
- Available in 8 mm Tape and Reel
 Use BAS116LT1 to order the 7 inch/3,000 unit reel
 Use BAS116LT3 to order the 13 inch/10,000 unit reel







MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	VR	75	Vdc
Peak Forward Current	lF	200	mAdc
Peak Forward Surge Current	IFM(surge)	500	mA

DEVICE MARKING

BAS116LT1 = JV

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board (1) T _A = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	R ₀ JA	556	°C/W
Total Device Dissipation	PD	300	mW
Alumina Substrate (2) T _A = 25°C Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	R ₀ JA	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

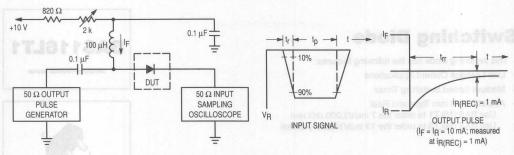
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{BR} = 100 \mu A$)	V _(BR)	75	- 1	٧
Reverse Voltage Leakage Current (V _R = 75 V) (V _R = 75 V, T _J = 150°C)	IR	==	5.0 80	nA
Forward Voltage (I _F = 1.0 mA) (I _F = 10 mA) (I _F = 50 mA) (I _F = 150 mA)	VF	=	900 1000 1100 1250	mV
Diode Capacitance (V _R = 0 V, f = 1.0 MHz)	C _D		2.0	pF
Reverse Recovery Time (I _F = I _R = 10 mA) (Figure 1)	t _{rr}		3.0	μs

⁽¹⁾ FR-5 = $1.0 \times 0.75 \times 0.062$ in.

Preferred devices are Motorola recommended choices for future use and best overall value.

⁽²⁾ Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.



Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (IF) of 10 mA.

2. Input pulse is adjusted so IR(peak) is equal to 10 mA.

3. tp » trr

Figure 1. Recovery Time Equivalent Test Circuit

MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	VR	70	Vdc
Forward Current	E BRUINF IF	200	mAdc
Peak Forward Surge Current	IFM(surge)	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_{\text{A}} = 25^{\circ}\text{C}$	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

*FR-5 = $1.0 \times 0.75 \times 0.062$ in.

**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

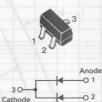
DEVICE MARKING

BAV70LT1 = A4

BAV70LT1*

PTJOTYA

CASE 318-07, STYLE 9 SOT-23 (TO-236AB)



MONOLITHIC DUAL SWITCHING DIODE

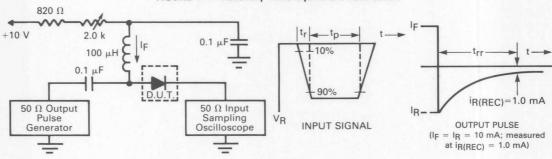
Anode

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.) (EACH DIODE)

Characteristic	c	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	FIGURE 4 — CAPACITANCE				
Reverse Breakdown Voltage (I _(BR) = 100 μAdc)		V _(BR)	>70	-	Vdc
Reverse Voltage Leakage Current (V _R = 25 Vdc, T _J = 150°C) (V _R = 70 Vdc) (V _R = 70 Vdc, T _J = 150°C)		IR see B	Ξ	60 2.5 100	μAdc
Diode Capacitance (V _R = 0, f = 1.0 MHz)		C _D		1.5	pF
Forward Voltage (IF = 1.0 mAdc) (IF = 10 mAdc) (IF = 50 mAdc) (IF = 150 mA)		V _F	Ē	715 855 1000 1250	mVdc
Reverse Recovery Time (I _F = I _R = 10 mAdc, V _R = 5.0 Vdc, I _R (REC) =	$R_L = 100\Omega$ = 1.0 mAdc) (Figure 1)	t _{rr}	-	6.0	ns

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (I_F) of 10 mA.

2. Input pulse is adjusted so IR(peak) is equal to 10 mA.

3. tp » trr

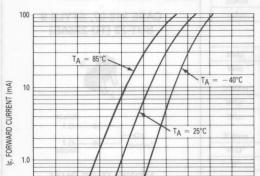


0.1 0.2

0.4

Curves Applicable to each Anode



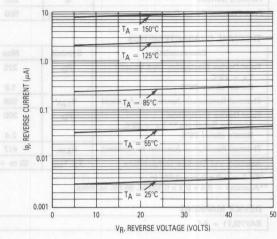


0.6

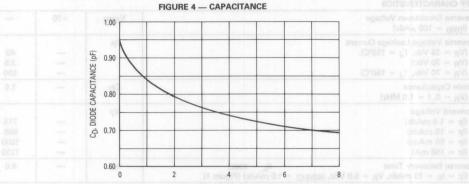
0.8

1.0

FIGURE 3 — LEAKAGE CURRENT



VF, FORWARD VOLTAGE (VOLTS) IS SOURCE IN A SECOND REPORTED AND A SECOND REPORT OF A SECON



VR, REVERSE VOLTAGE (VOLTS)

-VVV-----



Dual Switching Diode

BAV70WT1 Motorola Preferred Device

MAXIMUM RATINGS (TA = 25°C)

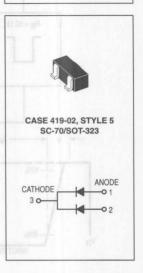
Rating	Symbol	Max	Unit
Reverse Voltage	VR	70	Vdc
Forward Current	I _F	200	mAdc
Peak Forward Surge Current	IFM(surge)	500	mAdc

DEVICE MARKING

A4

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board (1) TA = 25°C	PD	200	mW
Derate above 25°C	ale ale	1.6	mW/°C
Thermal Resistance Junction to Ambient	R ₀ JA	0.625	°C/W
Total Device Dissipation Alumina Substrate (2) T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	R ₀ JA	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	1160			
Reverse Breakdown Voltage (I _(BR) = 100 μAdc)	V _(BR)	70	T	Vdc
Reverse Voltage Leakage Current (V _R = 70 Vdc) (V _R = 50 Vdc)	I _{R1} I _{R2}	Cologi	5.0 100	μAdc nAdc
Diode Capacitance (V _R = 0, f = 1.0 MHz)	CD	Jt	1.5	pF
Forward Voltage (I _F = 1.0 mAdc) (I _F = 10 mAdc) (I _F = 50 mAdc) (I _F = 150 mAdc)	VF		715 855 1000 1250	mVdc
Reverse Recovery Time (I _F = I _R = 10 mAdc, R _L = 100 Ω , I _R (REC) = 1.0 mAdc) (Figure 1)	t _{rr}	-	6.0	ns
Forward Recovery Voltage ($I_F = 10 \text{ mA}, t_r = 20 \text{ ns}$) (Figure 2)	V _{RF}	_ 18108	1.75	V

Preferred devices are Motorola recommended choices for future use and best overall value.

⁽¹⁾ FR-5 = 1.0 x 0.75 x 0.062 in. (2) Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

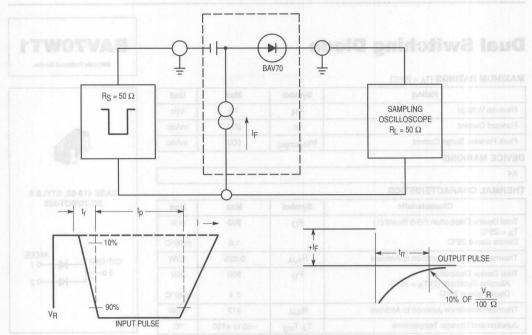
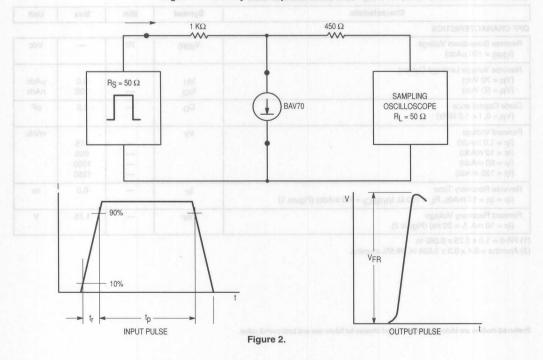


Figure 1. Recovery Time Equivalent Test Circuit





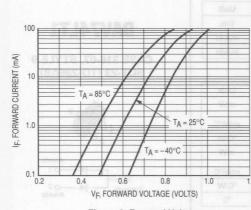


Figure 3. Forward Voltage

Figure 4. Leakage Current

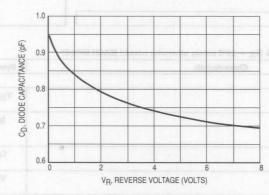


Figure 5. Capacitance

MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	VR	50	Vdc
Forward Current	I _F	200	mAdc
Peak Forward Surge Current	IFM(surge)	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
		1.0	IIIVV/ C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tstq	-55 to +150	°C

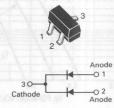
^{*}FR-5 = 1.0 x 0.75 x 0.062 in.

DEVICE MARKING

BAV74LT1 = JA

BAV74LT1

CASE 318-07, STYLE 9 SOT-23 (TO-236AB)



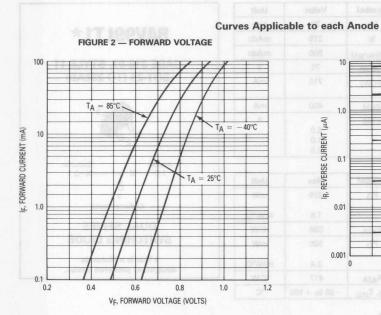
MONOLITHIC DUAL SWITCHING DIODE

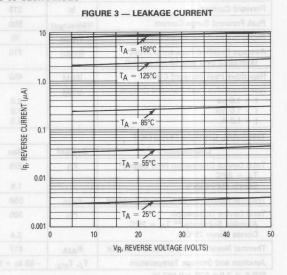
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.) (EACH DIODE)

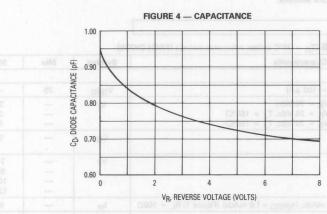
	Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS			100			
Reverse Breakdown Voltage ($I(BR) = 5.0 \mu Adc$)			V _(BR)	50	-	Vdc
Reverse Voltage Leakage Current ($V_R = 50 \text{ Vdc}$, $T_J = 125^{\circ}\text{C}$) ($V_R = 50 \text{ Vdc}$)			IR	_	100 0.1	μAdc
Diode Capacitance (V _R = 0, f = 1.0 MHz)		a) a)	CD	-	2.0	pF
Forward Voltage (I _F = 100 mAdc)	EVERSE VOLTAGE (VOLTS)	R _a v	VF	_	1.0	Vdc
Reverse Recovery Time (I _F = I _R = 10 mAdc, i _{R(REC)} = 1.0	mAdc, measured at I _R = 1.0 mA, R _I	= 100 Ω)	t _{rr}	-	4.0	ns

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.









MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	VR	70	Vdc
Forward Current	stress IF	215	mAdc
Peak Forward Surge Current	IFM(surge)	500	mAdc
Repetitive Peak Reverse Voltage	VRRM	70	V
Average Rectified Forward Current* (averaged over any 20 ms period)	lF(AV)	715	mA
Repetitive Peak Forward Current	IFRM	450	mA
Non-Repetitive Peak Forward Current t = 1.0 \mus t = 1.0 ms t = 1.0 A	IFSM	2.0 1.0 0.5	A

THERMAL CHARACTERISTICS

Symbol	Max	Unit
PD	225	mW
	1.8	mW/°C
$R_{\theta}JA$	556	°C/W
PD	300	mW
10	2.4	mW/°C
$R_{\theta JA}$	417	°C/W
TJ, T _{stg}	-65 to +150	°C
	PD R _θ JA PD R _θ JA	P _D 225 1.8 R _θ JA 556 P _D 300 2.4 R _θ JA 417

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

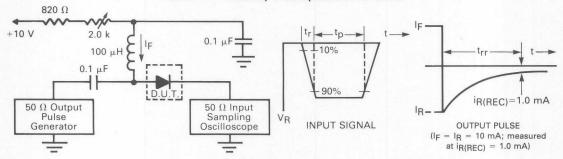
DEVICE MARKING

BAV99LT1 = A7

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) (EACH DIODE)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	/ 1			HE RE
Reverse Breakdown Voltage (I _(BR) = 100 μA)	V _(BR)	70	-	Vdc
Reverse Voltage Leakage Current (V _R = 70 Vdc) (V _R = 25 Vdc, T _J = 150°C) (V _R = 70 Vdc, T _J = 150°C)	IR (IEI)	=	2.5 30 50	μAdc
Diode Capacitance (V _R = 0, f = 1.0 MHz)	CD	-	1.5	pF
Forward Voltage (IF = 1.0 mAdc) (IF = 10 mAdc) (IF = 50 mAdc) (IF = 150 mAdc)	V _F	Ξ	715 855 1000 1250	mVdc
Reverse Recovery Time (I _F = I _R = 10 mAdc, $i_{R(REC)}$ = 1.0 mAdc) (Figure 1) R_{L} = 100 Ω	t _{rr}		6.0	ns
Forward Recovery Voltage (I _F = 10 mA, t _r = 20 ns)	VFR	_	1.75	V

FIGURE 1 — Recovery Time Equivalent Test Circuit



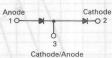
Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (I_F) of 10 mA.

- 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
- 3. tp » trr

BAV99LT1*

CASE 318-07, STYLE 11 SOT-23 (TO-236AB)





DUAL SERIES SWITCHING DIODE

★This is a Motorola designated preferred device.

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Curves Applicable to each Diode

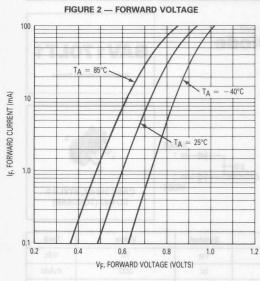


FIGURE 3 — LEAKAGE CURRENT

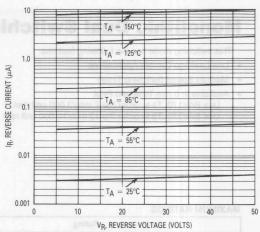
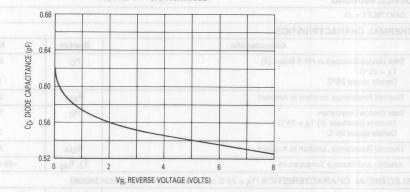


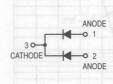
FIGURE 4 — CAPACITANCE



Monolithic Dual Switching Diode

This switching diode has the following features:

- Low Leakage Current Applications
- Medium Speed Switching Times
- Available in 8 mm Tape and Reel
 Use BAV170LT1 to order the 7 inch/3,000 unit reel
 Use BAV170LT3 to order the 13 inch/10,000 unit reel







MAXIMUM RATINGS

Pating Rating	Symbol	Value	Unit
Reverse Voltage	VR	70	Vdc
Forward Current	lF	200	mAdc
Peak Forward Surge Current	IFM(surge)	500	mAdc

DEVICE MARKING

BAV170LT1 = JX

THERMAL CHARACTERISTICS

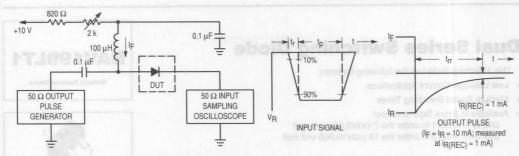
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board (1) TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	R ₀ JA	556	°C/W
Total Device Dissipation Alumina Substrate (2) T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	R ₀ JA	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted) (EACH DIODE)

Characteristic	Symbol	IVIII	wax	Unit
FF CHARACTERISTICS				
Reverse Breakdown Voltage (I _(BR) = 100 μA)	V _(BR)	70	_	Vdc
Reverse Voltage Leakage Current ($V_R = 70 \text{ V}$) ($V_R = 70 \text{ V}$, $T_J = 150 ^{\circ}\text{C}$)	IR	=	5.0 80	nAdc
Diode Capacitance (V _R = 0 V, f = 1.0 MHz)	CD	-	2.0	pF
Forward Voltage (IF = 1.0 mA) (IF = 10 mA) (IF = 50 mA) (IF = 150 mA)	VF	=	900 1000 1100 1250	mVdc
Reverse Recovery Time $R_L = (I_F = I_R = 10 \text{ mA})$ (Figure 1)	100 Ω t _{rr}	-	3.0	μs

⁽¹⁾ FR-5 = $1.0 \times 0.75 \times 0.062$ in.

⁽²⁾ Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.



Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (IF) of 10 mA.

- 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
- 3. tp » trr

Figure 1. Recovery Time Equivalent Test Circuit

	8		

Dual Series Switching Diode

This switching diode has the following features:

- Low Leakage Current Applications
- Medium Speed Switching Times
- Available in 8 mm Tape and Reel
 Use BAV199LT1 to order the 7 inch/3,000 unit reel
 Use BAV199LT3 to order the 13 inch/10,000 unit reel





CASE 318-07, STYLE 11 SOT-23 (TO-236AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	VR	70	Vdc
Forward Current	IF	215	mAdc
Peak Forward Surge Current	IFM(surge)	500	mAdc
Repetitive Peak Reverse Voltage	VRRM	70	V
Average Rectified Forward Current (1) (averaged over any 20 ms period)	IF(AV)	715	mA
Repetitive Peak Forward Current	IFRM	450	mA
Non-Repetitive Peak Forward Current $t = 1.0 \mu s$ t = 1.0 m s t = 1.0 A	IFSM	2.0 1.0 0.5	А

DEVICE MARKING

BAV199LT1 = JY

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board (1) T _A = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	R ₀ JA	556	°C/W
Total Device Dissipation Alumina Substrate (2) T _A = 25°C Derate above 25°C	PD	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	R ₀ JA	417	°C/W
Junction and Storage Temperature	T _J , T _{sta}	-65 to +150	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25$ °C unless otherwise noted) (EACH DIODE)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage (I _(BR) = 100 μA)	V _(BR)	70	_	Vdc
Reverse Voltage Leakage Current ($V_R = 70 \text{ V}$) ($V_R = 70 \text{ V}$, $T_J = 150 ^{\circ}\text{C}$)	IR	=	5.0 80	nAdc
Diode Capacitance (V _R = 0 V, f = 1.0 MHz)	C _D	_	2.0	pF
Forward Voltage (I _F = 1.0 mA) (I _F = 10 mA) (I _F = 50 mA) (I _F = 150 mA)	VF	=	900 1000 1100 1250	mVdc
Reverse Recovery Time (I _F = I _R = 10 mA) (Figure 1)	t _{rr}	_	3.0	μs

⁽¹⁾ FR-5 = $1.0 \times 0.75 \times 0.062$ in.

⁽²⁾ Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

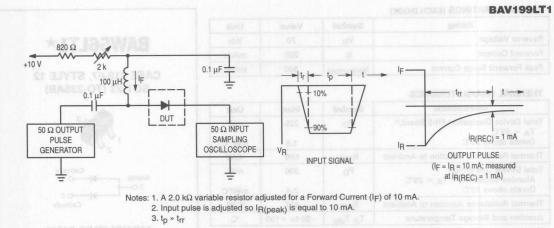
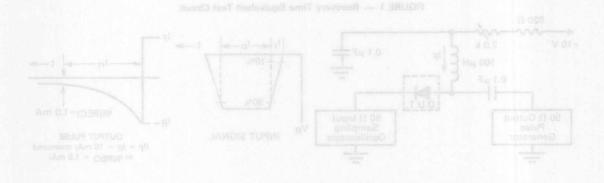


Figure 1. Recovery Time Equivalent Test Circuit

otward Voltage (Ip = 1.0 mAct) (Ip = 10 mAct) (Ip = 50 mAct) (Ip = 150 mAct)		



MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	VR	70	Vdc
Forward Current	l _E	200	mAdc
Peak Forward Surge Current	IFM(surge)	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_{A} = 25^{\circ}C$	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** TA = 25°C Derate above 25°C	PD	300 2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{stg}	-55 to +150	°C

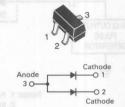
^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

BAW56LT1 = A1

BAW56LT1*

CASE 318-07, STYLE 12 SOT-23 (TO-236AB)



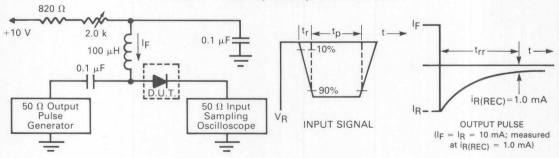
MONOLITHIC DUAL SWITCHING DIODE

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) (EACH DIODE)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage (I _(BR) = 100 μAdc)	V _(BR)	70	-	Vdc
Reverse Voltage Leakage Current (V _R = 25 Vdc, T _J = 150°C) (V _R = 70 Vdc) (V _R = 70 Vdc, T _J = 150°C)	lR	111	30 2.5 50	μAdc
Diode Capacitance (V _R = 0, f = 1.0 MHz)	CD		2.0	pF
Forward Voltage (IF = 1.0 mAdc) (IF = 10 mAdc) (IF = 50 mAdc) (IF = 150 mA)	V _F		715 855 1000 1250	mVdc
Reverse Recovery Time (IF = IR = 10 mAdc, IR(REC) = 1.0 mAdc) (Figure 1) R _L = 100Ω	t _{rr}	_	6.0	ns

FIGURE 1 — Recovery Time Equivalent Test Circuit

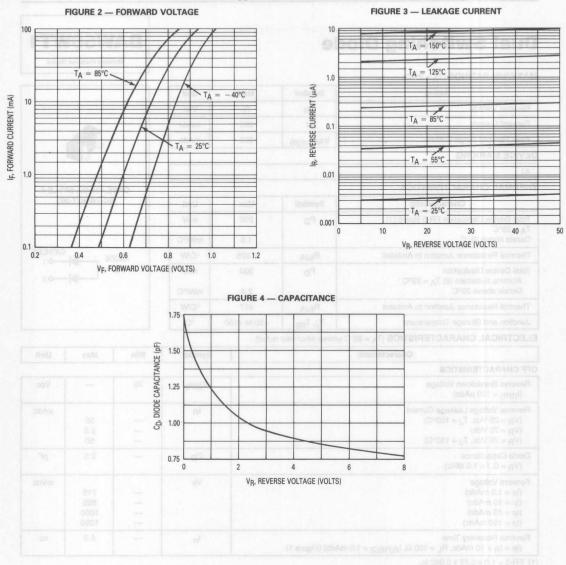


Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (I_F) of 10 mA.

- 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
- 3. tp » trr

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Curves Applicable to each Cathode



Dual Switching Diode

BAW56WT1 Motorola Preferred Device

MAXIMUM RATINGS (T_A = 25°C)

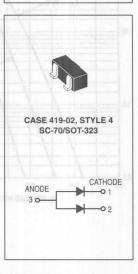
Rating	Symbol	Max	Unit
Reverse Voltage	V _R	70	Vdc
Forward Current	in ÜF	200	mAdc
Peak Forward Surge Current	I _{FM(surge)}	500	mAdc

DEVICE MARKING

A.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board (1) T _A = 25°C	PD PD	200	mW
Derate above 25°C		1.6	mW/°C
Thermal Resistance Junction to Ambient	R ₀ JA	0.625	°C/W
Total Device Dissipation Alumina Substrate (2) T _A = 25°C	PD	300	mW
Derate above 25°C	ana armani	2.4	mW/°C
Thermal Resistance Junction to Ambient	R ₀ JA	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

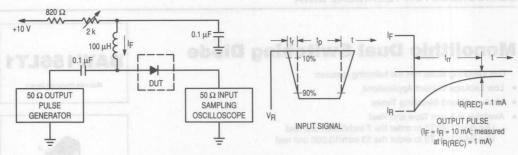


ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage (I _(BR) = 100 μAdc)	V _(BR)	70	-	Vdc
Reverse Voltage Leakage Current ($V_R = 25 \text{ Vdc}$, $T_J = 150 ^{\circ}\text{C}$) ($V_R = 70 \text{ Vdc}$) ($V_R = 70 \text{ Vdc}$, $T_J = 150 ^{\circ}\text{C}$)	I _R	=	30 2.5 50	μAdc
Diode Capacitance (V _R = 0, f = 1.0 MHz)	C _D	-	2.0	pF
Forward Voltage (IF = 1.0 mAdc) (IF = 10 mAdc) (IF = 60 mAdc) (IF = 60 mAdc)	VF	Ξ	715 855 1000 1250	mVdc
Reverse Recovery Time (IF = IR = 10 mAdc, RL = 100 Ω , IR(REC) = 1.0 mAdc) (Figure 1)	t _{rr}	-	6.0	ns

⁽¹⁾ FR-5 = $1.0 \times 0.75 \times 0.062$ in.

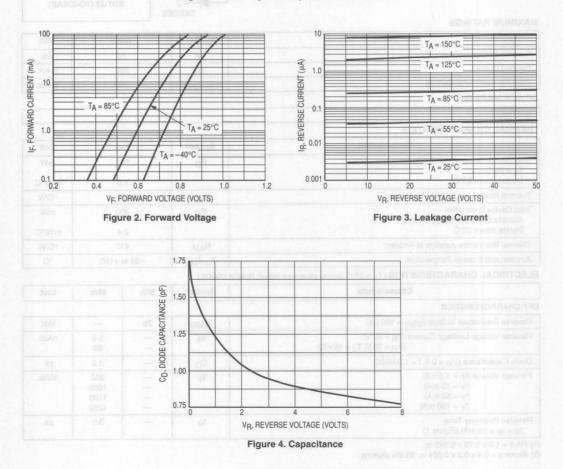
⁽²⁾ Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.



Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (IF) of 10 mA. 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.

3. tp » trr

Figure 1. Recovery Time Equivalent Test Circuit

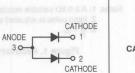


Monolithic Dual Switching Diode

This switching diode has the following features:

- · Low Leakage Current Applications
- Medium Speed Switching Times
- Available in 8 mm Tape and Reel
 Use BAW156LT1 to order the 7 inch/3,000 unit reel
 Use BAW156LT3 to order the 13 inch/10,000 unit reel







MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	VR	70	Vdc
Forward Current	IF.	200	mAdc
Peak Forward Surge Current	^I FM(surge)	500	mAdc

DEVICE MARKING

BAW156LT1 = JZ

THERMAL CHARACTERISTICS

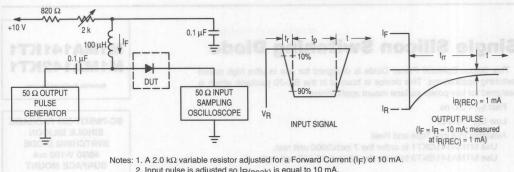
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board (1) TA = 25°C	PD	225	mW
Derate above 25°C	8.0	1.8	mW/°C
Thermal Resistance Junction to Ambient	R ₀ JA	556	°C/W
Total Device Dissipation Alumina Substrate (2) T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	ReJA	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted) (EACH DIODE)

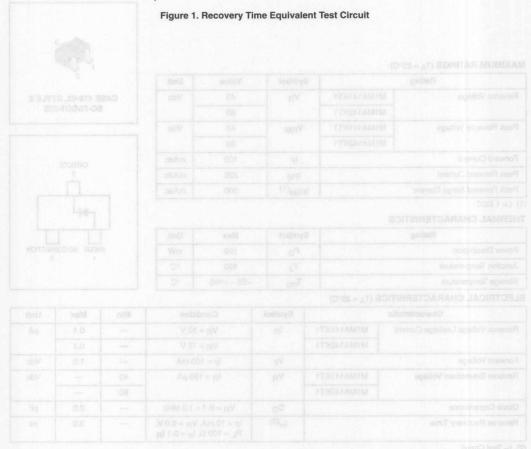
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	1/1	-		
Reverse Breakdown Voltage (I _(BR) = 100 μA)	V _(BR)	70		Vdc
Reverse Voltage Leakage Current (VR = 70 V) (VR = 70 V, TJ = 150°C)	I _R	1 1	5.0 80	nAdc
Diode Capacitance (V _R = 0 V, f = 1.0 MHz)	CD	8 -	2.0	pF
Forward Voltage (I _F = 1.0 mA) (I _F = 10 mA) (I _F = 50 mA) (I _F = 150 mA)	VF	8 - - -	900 1000 1100 1250	mVdc
Reverse Recovery Time (I _F = I _R = 10 mA) (Figure 1)	t _{rr}	-	3.0	μs

⁽¹⁾ FR-5 = 1.0 x 0.75 x 0.062 in.

⁽²⁾ Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.



2. Input pulse is adjusted so IR(peak) is equal to 10 mA.



Single Silicon Switching Diode

This Silicon Epitaxial Planar Diode is designed for use in ultra high speed switching applications. This device is housed in the SC-70 package which is designed for low power surface mount applications.

- Fast t_{rr}, < 3.0 ns
- Low C_D < 2.0 pF
- Available in 8 mm Tape and Reel
 Use M1MA141/2KT1 to order the 7 inch/3000 unit reel.

 Use M1MA141/2KT3 to order the 13 inch/10,000 unit reel.

M1MA141KT1 M1MA142KT1

Motorola Preferred Devices

SC-70/SOT-323 PACKAGE SINGLE SILICON SWITCHING DIODE 40/80 V-100 mA SURFACE MOUNT

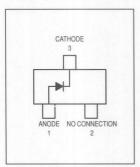
MAXIMUM RATINGS (TA = 25°C)

Rating	1	Symbol	Value	Unit	
Reverse Voltage	M1MA141KT1	VR	40	Vdc	
	M1MA142KT1		80		
Peak Reverse Voltage	M1MA141KT1	V _{RM}	40	Vdc	
	M1MA142KT1		80		
Forward Current		IF	100	mAdo	
Peak Forward Current		IFM	225	mAdd	
Peak Forward Surge Current		IFSM ⁽¹⁾	500	mAdd	

(1) t = 1 SEC

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	150	mW
Junction Temperature	TJ	150	°C
Storage Temperature	T _{stg}	-55 ~ +150	°C

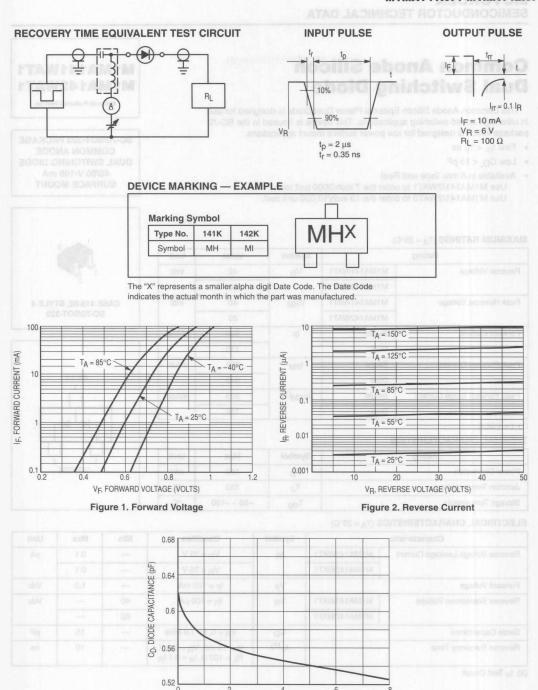


CASE 419-02, STYLE 2 SC-70/SOT-323

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA141KT1	IR	V _R = 35 V	-	0.1	μА
	M1MA142KT1		V _R = 75 V	-	0.1	
Forward Voltage		VF	I _F = 100 mA	_	1.2	Vdc
Reverse Breakdown Voltage	M1MA141KT1	VR	I _R = 100 μA	40	_	Vdc
	M1MA142KT1			80	_	
Diode Capacitance		CD	V _R = 0, f = 1.0 MHz	-	2.0	pF
Reverse Recovery Time		t _{rr} (2)	$I_F = 10 \text{ mA}, V_R = 6.0 \text{ V},$ $R_L = 100 \Omega, I_{rr} = 0.1 I_R$	-	3.0	ns

(2) t_{rr} Test Circuit



V_R, REVERSE VOLTAGE (VOLTS)

Figure 3. Diode Capacitance

Common Anode Silicon Dual Switching Diode

This Common Anode Silicon Epitaxial Planar Dual Diode is designed for use in ultra high speed switching applications. This device is housed in the SC-70 package which is designed for low power surface mount applications.

- Fast t_{rr}, < 10 ns
- Low C_{D.} < 15 pF
- Available in 8 mm Tape and Reel
 Use M1MA141/2WAT1 to order the 7 inch/3000 unit reel.
 Use M1MA141/2WAT3 to order the 13 inch/10,000 unit reel.

MAXIMUM RATINGS (TA = 25°C)

Rating		Symbol	Value	Unit	
Reverse Voltage	M1MA141WAT1	VR	40	Vdc	
	M1MA142WAT1	at Date Code: Y	80	s sinesev	
Peak Reverse Voltage	M1MA141WAT1	T1 V _{RM}	40	Vdc	
	M1MA142WAT1		80		
Forward Current	Single	I _F	100	mAdc	
	Dual		150	1/2	
Peak Forward Current	Single	IFM	225	mAdo	
	Dual		340		
Peak Forward Surge Current	Single	IFSM ⁽¹⁾	500	mAdc	
	Dual	昌 ※	750		

(1) t = 1 SEC

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	150	mW
Junction Temperature	TJ	150	°C
Storage Temperature	T _{stg}	-55 ~ +150	°C

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA141WAT1	IR	V _R = 35 V		0.1	μΑ
	M1MA142WAT1		V _R = 75 V	-	0.1	
Forward Voltage		VF	I _F = 100 mA	_	1.2	Vdc
Reverse Breakdown Voltage	M1MA141WAT1	VR	I _R = 100 μA	40	-	Vdc
	M1MA142WAT1		T1 1 /1 8	80	-	
Diode Capacitance		CD	V _R = 0, f = 1.0 MHz		15	pF
Reverse Recovery Time		t _{rr} (2)	$I_F = 10 \text{ mA}, V_R = 6.0 \text{ V},$ $R_L = 100 \Omega, I_{rr} = 0.1 I_R$		10	ns

⁽²⁾ t_{rr} Test Circuit

Preferred devices are Motorola recommended choices for future use and best overall value.

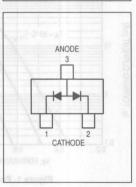
M1MA141WAT1 M1MA142WAT1

Motorola Preferred Devices

SC-70/SOT-323 PACKAGE COMMON ANODE DUAL SWITCHING DIODE 40/80 V-100 mA SURFACE MOUNT



CASE 419-02, STYLE 4 SC-70/SOT-323



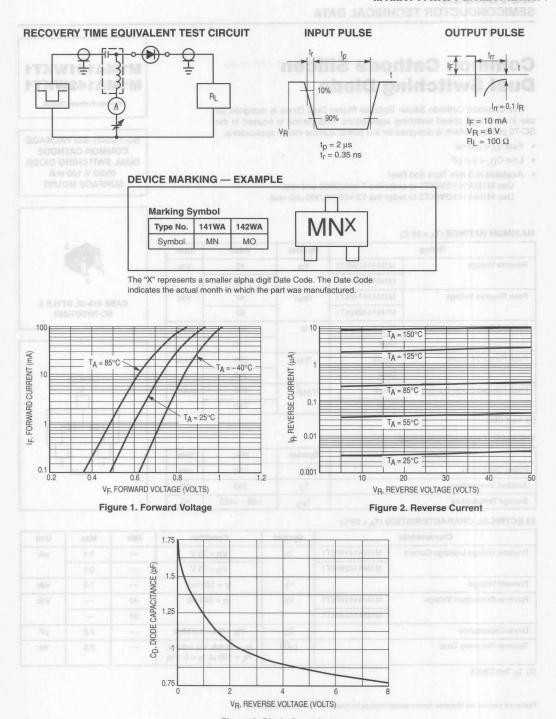


Figure 3. Diode Capacitance

Common Cathode Silicon Dual Switching Diode

This Common Cathode Silicon Epitaxial Planar Dual Diode is designed for use in ultra high speed switching applications. This device is housed in the SC-70 package which is designed for low power surface mount applications.

- Fast t_{rr}, < 3.0 ns
- Low C_D, < 2.0 pF
- Available in 8 mm Tape and Reel
 Use M1MA141/2WKT1 to order the 7 inch/3000 unit reel.
 Use M1MA141/2WKT3 to order the 13 inch/10,000 unit reel.

MAXIMUM RATINGS (TA = 25°C)

Rating		Symbol	Value	Unit
Reverse Voltage	M1MA141WKT1	VR	40	Vdc
	M1MA142WKT1	Bate Code The	80	ne is striped
Peak Reverse Voltage	M1MA141WKT1	V _{RM}	40	Vdc
	M1MA142WKT1		80	
Forward Current	Single	01 IF	100	mAdc
	Dual		150	
Peak Forward Current	Single	IFM	225	mAdc
	Dual		340	
Peak Forward Surge Current	Single	I _{FSM} ⁽¹⁾	500	mAdc
	Dual	10 8	750	

(1) t = 1 SEC

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	150	mW
Junction Temperature	TJ	150	°C
Storage Temperature	T _{stg}	-55 ~ +150	°C

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA141WKT1	IR	V _R = 35 V	-	0.1	μА
	M1MA142WKT1		V _R = 75 V	2 -	0.1	
Forward Voltage		VF	I _F = 100 mA	-	1.2	Vdc
Reverse Breakdown Voltage	M1MA141WKT1	VR	I _R = 100 μA	40	-	Vdc
	M1MA142WKT1			80	-	
Diode Capacitance		CD	V _R = 0, f = 1.0 MHz	š —	2.0	pF
Reverse Recovery Time		t _{rr} (2)	$I_F = 10 \text{ mA}, V_R = 6.0 \text{ V},$ $R_L = 100 \Omega, I_{rr} = 0.1 I_R$	8	3.0	ns

(2) t_{rr} Test Circuit

Preferred devices are Motorola recommended choices for future use and best overall value.

Rev 2

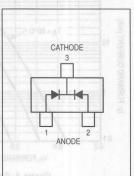
M1MA141WKT1 M1MA142WKT1

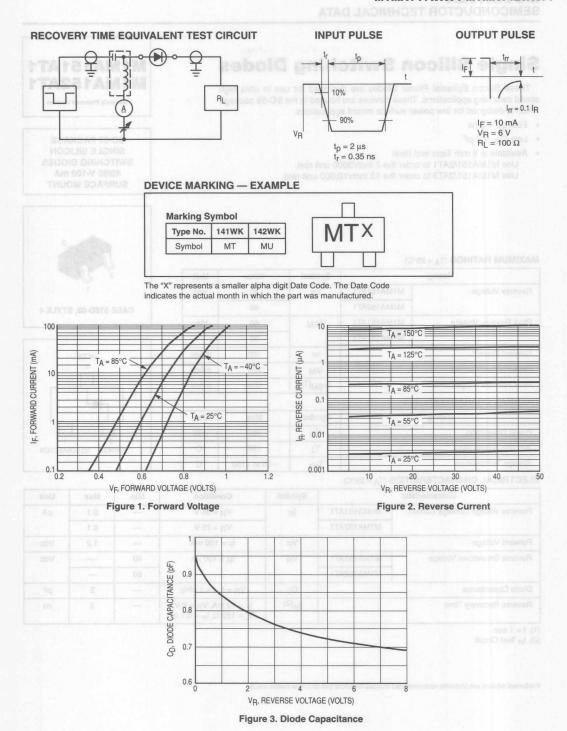
Motorola Preferred Devices

SC-70/SOT-323 PACKAGE COMMON CATHODE DUAL SWITCHING DIODE 40/80 V-100 mA SURFACE MOUNT



CASE 419-02, STYLE 5 SC-70/SOT-323





Single Silicon Switching Diodes

These Silicon Epitaxial Planar Diodes are designed for use in ultra high speed switching applications. These devices are housed in the SC-59 package which is designed for low power surface mount applications.

- Fast trr, < 3 ns
- Low C_D, < 2 pF
- Available in 8 mm Tape and Reel
 Use M1MA151/2AT1 to order the 7 inch/3000 unit reel.

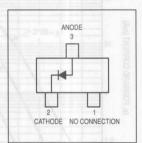
 Use M1MA151/2AT3 to order the 13 inch/10,000 unit reel.

M1MA151AT1 M1MA152AT1

Motorola Preferred Devices

SC-59 PACKAGE SINGLE SILICON SWITCHING DIODES 40/80 V-100 mA SURFACE MOUNT





MAXIMUM RATINGS (TA = 25°C)

Rating		Symbol	Value	Unit
Reverse Voltage	M1MA151AT1	VR	40	Vdc
	M1MA152AT1		80	
Peak Reverse Voltage	M1MA151AT1	V _{RM}	и 40	Vdc
	M1MA152AT1		80	
Forward Current		IF 8	100	mAdo
Peak Forward Current		IFM	225	mAdo
Peak Forward Surge Current		IFSM ⁽¹⁾	500	mAdd

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	TJ	150	°C
Storage Temperature	T _{stg}	-55 to +150	°C

FLECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	Current M1MA151AT1 IR	V _R = 35 V	O I T O SUPE	0.1	μА	
	M1MA152AT1	M1MA152AT1	V _R = 75 V	_	0.1	
Forward Voltage		VF	I _F = 100 mA		1.2	Vdc
Reverse Breakdown Voltage	M1MA151AT1	VR	I _R = 100 μA	40	_	Vdc
	M1MA152AT1			80	_	
Diode Capacitance		CD	V _R = 0, f = 1 MHz		2	pF
Reverse Recovery Time		t _{rr} (2)	$I_F = 10 \text{ mA}, V_R = 6 \text{ V},$ $R_L = 100 \Omega, I_{rr} = 0.1 I_R$		3	ns

⁽¹⁾ $t = 1 \sec$

⁽²⁾ t_{rr} Test Circuit

OUTPUT PULSE RECOVERY TIME EQUIVALENT TEST CIRCUIT **INPUT PULSE** t 10% well to bendiable Irr = 0.1 IR 90% IF = 10 mA VR VR = 6 V $R_L = 100 \Omega$ $t_p = 2 \, \mu s$ $t_r = 0.35 \text{ ns}$ **DEVICE MARKING Marking Symbol** Type No. 151A 152A MB Symbol MA TES = AT) SOUTTAR MUMIXAM The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

Single Silicon Switching Diodes

These Silicon Epitaxial Planar Diodes are designed for use in ultra high speed switching applications. These devices are housed in the SC-59 package which is designed for low power surface mount applications.

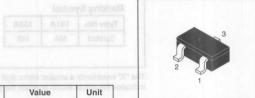
- Fast trr, < 3 ns
- Low C_D, < 2 pF
- Available in 8 mm Tape and Reel
 Use M1MA151/2KT1 to order the 7 inch/3000 unit reel.

 Use M1MA151/2KT3 to order the 13 inch/10,000 unit reel.

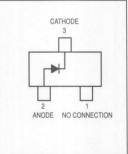
M1MA151KT1 M1MA152KT1

Motorola Preferred Devices

SC-59 PACKAGE SINGLE SILICON SWITCHING DIODES 40/80 V-100 mA SURFACE MOUNT







MAXIMUM RATINGS (TA = 25°C)

Rating		Symbol	Value	Unit
Reverse Voltage	M1MA151KT1	VR	V _R 40	Vdc
	M1MA152KT1		80	
Peak Reverse Voltage	M1MA151KT1	151KT1 V _{RM} 40	40	Vdc
	M1MA152KT1		80	
Forward Current		IF.	100	mAdc
Peak Forward Current		IFM	225	mAdc
Peak Forward Surge Current		IFSM ⁽¹⁾	500	mAdc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	TJ	150	°C
Storage Temperature	T _{stg}	-55 to +150	°C

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA151KT1	IR	V _R = 35 V		0.1	μА
	M1MA152KT1		V _R = 75 V	-	0.1	
Forward Voltage		VF	I _F = 100 mA	-	1.2	Vdc
Reverse Breakdown Voltage	M1MA151KT1	VR	I _R = 100 μA	40	_	Vdc
	M1MA152KT1			80	-	
Diode Capacitance		CD	V _R = 0, f = 1 MHz	_	2	pF
Reverse Recovery Time		t _{rr} (2)	$I_F = 10 \text{ mA}, V_R = 6 \text{ V},$ $R_L = 100 \Omega, I_{rr} = 0.1 I_R$	-	3	ns

⁽¹⁾ t = 1 SEC

(2) t_{rr} Test Circuit

RECOVERY TIME EQUIVALENT TEST CIRCUIT **INPUT PULSE OUTPUT PULSE** 10% Irr = 0.1 IR 90% IF = 10 mA V_R = 6 V V_R $R_L = 100 \Omega$ $t_p = 2 \mu s$ $t_r = 0.35 \text{ ns}$ **DEVICE MARKING — EXAMPLE** Use M1MA151/2V AT3 to order the 13 in **Marking Symbol** MHX Type No. 151K 152K Symbol MH MI The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

Common Anode Silicon Dual Switching Diodes

These Common Anode Silicon Epitaxial Planar Dual Diodes are designed for use in ultra high speed switching applications. These devices are housed in the SC-59 package which is designed for low power surface mount applications.

- Fast t_{rr}, < 10 ns
- Low C_D, < 15 pF
- Available in 8 mm Tape and Reel Use M1MA151/2WAT1 to order the 7 inch/3000 unit reel. Use M1MA151/2WAT3 to order the 13 inch/10,000 unit reel.

MAXIMUM RATINGS (TA = 25°C)

Rating		Symbol	Value	Unit
Reverse Voltage	M1MA151WAT1	VR	40	Vdc
	M1MA152WAT1	Fushoo sisu	80	oteono le
Peak Reverse Voltage	M1MA151WAT1	V _{RM}	40	Vdc
	M1MA152WAT1		80	
Forward Current	Single	I _F	100	mAdc
	Dual		150	
Peak Forward Current	Single	IFM	225	mAdc
	Dual		340	
Peak Forward Surge Current	Single	IFSM ⁽¹⁾	500	mAdc
	Dual		750	

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	TJ	150	°C
Storage Temperature	T _{stg}	-55 to +150	°C

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA151WAT1	I _R	V _R = 35 V	:	0.1	μА
	M1MA152WAT1		V _R = 75 V	_	0.1	
Forward Voltage		VF	I _F = 100 mA		1.2	Vdc
Reverse Breakdown Voltage	M1MA151WAT1	VR	I _R = 100 μA	40		Vdc
	M1MA152WAT1			80	- 1	
Diode Capacitance		CD	V _R = 0, f = 1 MHz	— — — — — — — — — — — — — — — — — — —	15	pF
Reverse Recovery Time		t _{rr} (2)	$I_F = 10 \text{ mA}, V_R = 6 \text{ V},$ $R_I = 100 \Omega, I_{rr} = 0.1 \text{ IB}$		10	ns

⁽¹⁾ t = 1 SEC

Preferred devices are Motorola recommended choices for future use and best overall value.

M1MA152WAT1

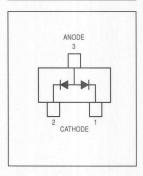
Motorola Preferred Devices

M1MA151WAT1

SC-59 PACKAGE **COMMON ANODE DUAL SWITCHING DIODES** 40/80 V-100 mA SURFACE MOUNT







⁽²⁾ t_{rr} Test Circuit

INPUT PULSE **OUTPUT PULSE** RECOVERY TIME EQUIVALENT TEST CIRCUIT 10% Irr = 0.1 IR 90% IF = 10 mA VR V_B = 6 V $R_L = 100 \Omega$ $t_p = 2 \mu s$ $t_r = 0.35 \text{ ns}$ **DEVICE MARKING — EXAMPLE Marking Symbol** Type No. 151WA 152WA MN МО Symbol The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

Common Cathode Silicon Dual Switching Diodes

These Common Cathode Silicon Epitaxial Planar Dual Diodes are designed for use in ultra high speed switching applications. These devices are housed in the SC-59 package which is designed for low power surface mount applications.

- Fast trr, < 3 ns
- Low CD, < 2 pF
- Available in 8 mm Tape and Reel
 Use M1MA151/2WKT1 to order the 7 inch/3000 unit reel.

 Use M1MA151/2WKT3 to order the 13 inch/10,000 unit reel.

MAXIMUM RATINGS (TA = 25°C)

Rating	Lycy	Symbol	Value	Unit
Reverse Voltage	M1MA151WKT1	VR	40	Vdc
	M1MA152WKT1	Date Code.	80	toma is a
Peak Reverse Voltage	M1MA151WKT1	V _{RM}	40	Vdc
	M1MA152WKT1		80	
Forward Current	Single	lF	100	mAdc
	Dual	11	150	
Peak Forward Current	Single	IFM	225	mAdc
	Dual		340	
Peak Forward Surge Current	Single	IFSM ⁽¹⁾	500	mAdc
	Dual		750	

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	PD	200	mW
Junction Temperature	TJ	150	°C
Storage Temperature	T _{stg}	-55 to +150	°C

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA151WKT1	IR	V _R = 35 V		0.1	μА
	M1MA152WKT1		V _R = 75 V		0.1	
Forward Voltage		VF	I _F = 100 mA		1.2	Vdc
Reverse Breakdown Voltage	M1MA151WKT1	VR	I _R = 100 μA	40	_	Vdc
	M1MA152WKT1			80		
Diode Capacitance		CD	V _R = 0, f = 1 MHz		2	pF
Reverse Recovery Time		t _{rr} (2)	$I_F = 10 \text{ mA}, V_R = 6 \text{ V},$ $R_L = 100 \Omega, I_{rr} = 0.1 I_R$		3	ns

- (1) t = 1 SEC
- (2) t_{rr} Test Circuit

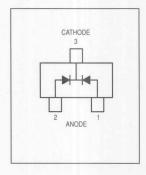
Preferred devices are Motorola recommended choices for future use and best overall value.

M1MA151WKT1 M1MA152WKT1

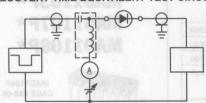
Motorola Preferred Devices

SC-59 PACKAGE
COMMON CATHODE
DUAL SWITCHING DIODES
40/80 V-100 mA
SURFACE MOUNT

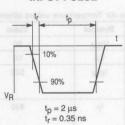




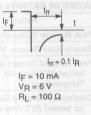
RECOVERY TIME EQUIVALENT TEST CIRCUIT



INPUT PULSE

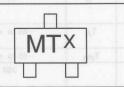


OUTPUT PULSE



DEVICE MARKING — EXAMPLE

	Marking Symbol			
ITHIC DIODE ARRAY	Type No.	151WK	152WK	
	Symbol	MT	MU	



The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

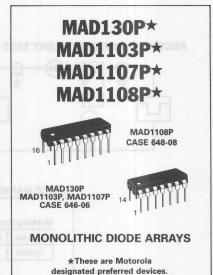
Dual B Dude Array
T4-Pin Fackage

(a) (a) (b) (b) (c)

Operation Processing

MAXIMUM RATINGS (@ 25°C Free-Air Temperature unless otherwise noted.)

Rating	Symbol	Value	Unit
Peak Reverse Voltage(1)	V _{RM}	50	Vdc
Steady-State Reverse Voltage	VR	50	Vdc
Peak Forward Current at (or below) 25°C Free-Air Temperature(1)	IFM	500	mA
Continuous Forward Current at (or below) 25°C Free-Air Temperature(2)		400	mA
Continuous Power Dissipation at (or below) 25°C Free-Air Temperature(3)	PD	600	mW
Operating Free-Air Temperature Range	ТА	-65 to +125	°C
Storage Temperature Range	T _{stg}	-65 to +150	°C
Lead Temperature 1/16" from Case for 10 Seconds		260	°C



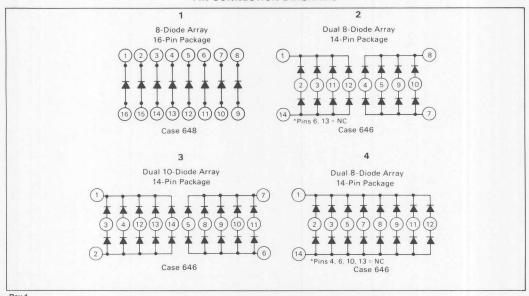
NOTES:

- 1. These values apply for PW \leq 100 μ s, duty cycle \leq 20%.
- 2. Derate linearity to +125°C temperature at rate of 3.2 mA/°C.
- 3. Derate linearity to +125°C temperature at rate of 6.0 mW/°C.

PACKAGE OPTIONS

	PLASTIC P Suffix		- Device	PLASTIC P Suffix	
Device	Pin Connection Ref. No.	Case		Pin Connection Ref. No.	Case
MAD130P Dual 10-Diode Array	3	646-06	MAD1107P Dual 8-Diode Array	2	646-06
MAD1103P Dual 8-Diode Array	4	646-06	MAD1108P 8-Diode Array	1	648-08

PIN CONNECTION DIAGRAMS



Rev 1

ELECTRICAL CHARACTERISTICS (@ 25°C Free-Air Temperature)

	BMIT YREVOORS SERSVER	_ g anu Limit		
Characteristic	Symbol	Min	Max	Unit
Reverse Breakdown Voltage(1) (I _R = 10 μA)	V _(BR)	50		Vdc
Static Reverse Current (V _R = 40 V)	IR		0.1	μΑ
117021	71 TOD 67			N/J
Static Forward Voltage (I _F = 100 mA) (I _F = 500 mA)(2)	VF-Am 0	200 m Neto to 65 Net Pole <u>n</u> SC 120 to	1.2 1.6	Vdc
Peak Forward Voltage(3) (I _F = 500 mA)	VFM	rusy gyetty g s en VV < 200 me out = 50 nimbs	5.0	Vdc

SWITCHING CHARACTERISTICS (@ 25°C Free-Air Temperature)

Characteristic	Symbol	Typical Value		Unit
Forward Recovery Time, Figure 3 (I _F = 500 mA)	tfr			
Reverse Recovery Time, Figure 2	t _{rr}	MAD1108	8.0	ns
$(I_F = 200 \text{ mA}, I_{RM} = 200 \text{ mA}, R_L = 100 \Omega, i_{rr} = 20 \text{ mA})$		Others	10.0	

- This parameter must be measured using pulse techniques. PW = 100 μs, duty cycle ≤ 20%.
 This parameter is measured using pulse techniques. PW = 300 μs, duty cycle ≤ 2.0%. Read time is 90 μs from the leading edge of the
- 3. The initial instantaneous value is measured using pulse techniques. PW = 150 ns, duty cycle ≤ 2.0%, pulse rise time ≤ 10 ns. The total capacitance shunting the diode is 19 pF maximum and the equipment bandwidth is 80 MHz.

FIGURE 1 — TYPICAL CHARACTERISTICS STATIC FORWARD VOLTAGE

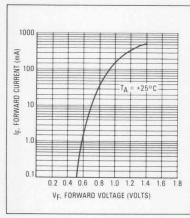
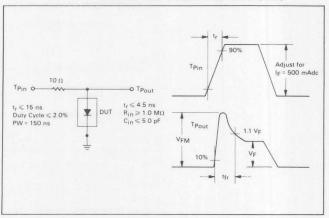
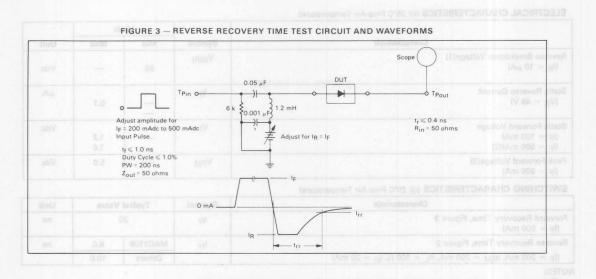


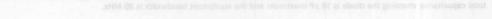
FIGURE 2 — FORWARD RECOVERY TIME AND PEAK FORWARD **VOLTAGE TEST CIRCUIT AND WAVEFORMS**

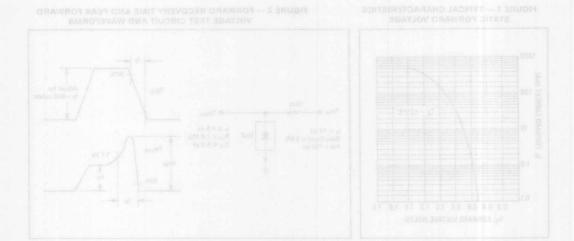


MAD130P MAD1103P MAD1107P MAD1108P







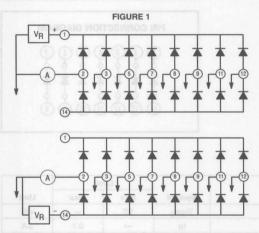


TEST PROCEDURE FOR MULTIPLE DIODES

1.0. REVERSE BIAS TESTING

1.1. LEAKAGE

Regardless of device configuration type, when testing any reverse bias condition, the forcing power supply must be applied only to the uncommon terminal of the pair. As in Figure 1, this would be pins 1 and 14. This can be referred as the high side of the test circuit. The low side of the test circuit must be connected to the common terminal of the pair which in most testers is where the current measurement is taken. This method is used to eliminate the possibility of degrading the diode in that pair which is not under test. Diode arrays with multiple pairs such as the MAD1103, also have leakage paths in the die between common terminals of the pairs. To isolate the device under test so that the leakage from the other pairs in the package do not affect the test result, the leakage current from the common terminals of the pairs not under test must be shunted to measurement common. Figure 1 shows the test configuration for both of these cases.

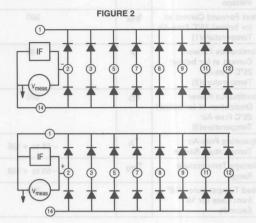


1.2. BREAKDOWN

It is not recommended to test breakdown on these devices due to the possibility of degrading the device. Breakdown may be checked on a curve tracer but extreme caution should be used.

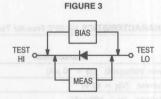
2.0. FORWARD BIAS TESTING

Diode arrays are designed with the pairs in parallel therefore care must be taken to prevent the other diodes in the array from affecting the measured value of the diode under test. Figure 2 illustrates the proper technique to measure only the correct value of the diode under test.



2.1. KELVIN CONNECTION

To achieve the best possible accuracy when testing bias currents over 10 mA, Kelvin connection to the leads of the device under test is mandatory. True Kelvin connection dictates that two test connections are made directly to the leads of the device. One is for power which is the bias supply, and the other is for sense which is for the measurement circuit. Kelvin connections are used to eliminate the effects of the connection resistance between the lead of the device and the contacts of the test handler and/or hand fixture. Figure 3 is an example of Kelvin connection.



2.2. PULSE TESTING

When testing bias currents over 10 mA, pulse testing should be used to minimize thermal drift of the measured value. The pulse width of a pulse test is approximately 300 μ s to 380 μ s.

3.0. TESTING PROTOCOL

3.1. TEST TYPES

When testing in sequence all of the electrical characteristics, all reverse bias conditions should be tested before the forward bias conditions are tested.

3.2. BIASING MAGNITUDES

Tests of the same test type should be grouped together with the bias conditions in ascending order. For example:

VF @ 10 mA < 0.6 V

VF @ 50 mA < 0.8 V

VF @ 100 mA < 1 V

VF @ 500 mA < 1.5 V

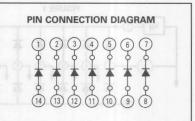
MAXIMUM RATINGS (@ 25°C Free-Air Temperature unless otherwise noted.)

Rating	Symbol	Value		Unit		
Peak Reverse Voltage(1)	V _{RM}	50		Vdc		
Steady-State Reverse Voltage	VR	50		V _R 50	OR BRO	Vdc
Peak Forward Current at (or below) 25°C Free-Air Temperature(1)	1 141			mA		
Continuous Forward Current at (or below) 25°C Free-Air Temperature(2)	ÎF O	400	enug enug rigiri	mA		
Continuous Power Dissipation at (or below) 25°C Free-Air Temperature(3)	PD	600	ed to teom striff exti	mW		
Operating Free-Air Temperature Range	TA	-55 to +125		°C		
Storage Temperature Range	T _{stg}	-55 to +150	ensid	°C		
Lead Temperature 1/16" – from Case for 10 Seconds	* * 3	260	ed ta	°C		

MAD1109P* MONOLITHIC DIODE ARRAY **★This is a Motorola**

NOTES:

- 1. These values apply for PW \leq 100 μ s, duty cycle \leq 20%.
- 2. Derate linearity to +125°C temperature at rate of 3.2 mA/°C.
- 3. Derate linearity to +125°C temperature at rate of 6.0 mW/°C.



designated preferred device.

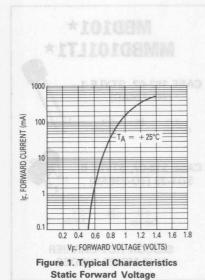
ELECTRICAL CHARACTERISTICS (@ 25°C Free-Air Temperature)

		Limit		0 11	
Characteristic	Symbol	Min	Max	Unit	
Reverse Breakdown Voltage(4) (I _R = 10 μA)	V(BR)	50		Vdc	
Static Reverse Current (V _R = 40 V)	IR		0.1	μΑ	
Static Forward Voltage (I _F = 100 mA) (I _F = 500 mA)(5)	VF	end least of b	1.20 1.60	Vdc	
Peak Forward Voltage(6) (I _F = 500 mA)	V _{FM}	nti gra llu arpel	5.0	Vdc	

SWITCHING CHARACTERISTICS (@ 25°C Free-Air Temperature)

Characteristic	Symbol	Typical Value	Unit
Forward Recovery Time, Figure 3 (I _F = 500 mA)	tfr	20	ns
Reverse Recovery Time, Figure 2 (IF = 200 mA, I _{RM} = 200 mA, R _L = 100 Ω , I _{rr} = 20 mA)	t _{rr}	8.0	ns

- 4. This parameter must be measured using pulse techniques. PW = 100 μs, duty cycle ≤ 20%.
 5. This parameter is measured using pulse techniques. PW = 300 μs, duty cycle ≤ 2.0%. Read time is 90 μs from the leading edge of the
- 6. The initial instantaneous value is measured using pulse techniques. PW = 150 ns, duty cycle ≤ 2.0%, pulse rise time ≤ 10 ns. The total capacitance shunting the diode is 19 pF maximum and the equipment bandwidth is 80 MHz.



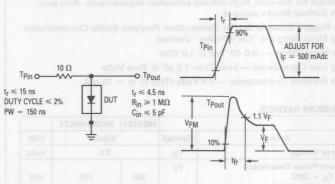


Figure 2. Forward Recovery Time and Peak Forward **Voltage Test Circuit and Waveforms**

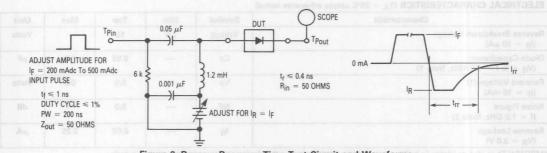


Figure 3. Reverse Recovery Time Test Circuit and Waveforms

SILICON HOT-CARRIER DIODE (SCHOTTKY BARRIER DIODE)

... designed primarily for UHF mixer applications but suitable also for use in detector and ultra-fast switching circuits. Supplied in an inexpensive plastic package for low-cost, high-volume consumer requirements. Also available in Surface Mount package.

- The Rugged Schottky Barrier Construction Provides Stable Characteristics by Eliminating the "Cat-Whisker" Contact
- Low Noise Figure 6.0 dB Typ @ 1.0 GHz
- Very Low Capacitance Less Than 1.0 pF @ Zero Volts
- High Forward Conductance 0.5 Volts (Typ) @ IF = 10 mA

MAXIMUM RATINGS

	MRV	MBD101	MMBD101LT1					
Rating	Symbol		Value	Unit				
Reverse Voltage	VR	V _R 7.0		7.0		VR	Volts	
Forward Power Dissipation @ T _A = 25°C Derate above 25°C	PF	280 2.8	200 2.0	mW mW/°C				
Junction Temperature	TJ	+125		°C				
Storage Temperature Range	T _{sta}	- 5	°C					

DEVICE MARKING

MMBD101LT1 = 4M

MBD101* MMBD101LT1*

CASE 182-02, STYLE 1 (TO-226AC)

> 2 O O 1 Cathode Anode

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)

3 O O 1 Cathode Anode

SILICON HOT-CARRIER
UHF MIXER DIODES

★These are Motorola designated preferred devices.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage $(I_R = 10 \mu A)$	100 ¹ 1 0-0-10	V _{(BR)R}	7.0	10	FL	Volts
Diode Capacitance (V _R = 0, f = 1.0 MHz, Note 1)		CT	-	0.88	1.0	pF
Forward Voltage (1) (I _F = 10 mA)	SMH - BO OHMS	V _F	Total 100	0.5	0.6	Volts
Noise Figure (f = 1.0 GHz, Note 2)	yi ==	NF		6.0	$ITV C\underline{\underline{VG}}.\xi \le 1$ $V = 200 \text{ ns}$	dB
Reverse Leakage (V _R = 3.0 V)		I _R	_	0.02	0.25	μΑ

MMBD101LT1 is also available in bulk packaging. Use MMBD101L as the device title to order this device in bulk.

TYPICAL CHARACTERISTICS

(T_A = 25°C unless noted)



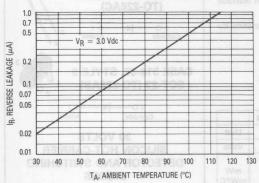


FIGURE 2 — FORWARD VOLTAGE

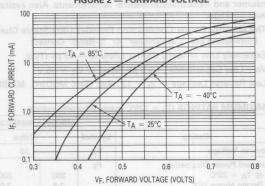


FIGURE 3 — CAPACITANCE

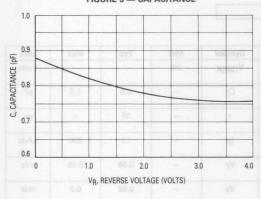


FIGURE 4 — NOISE FIGURE

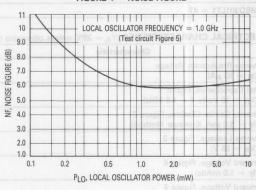
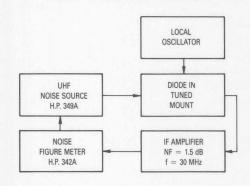


FIGURE 5 — NOISE FIGURE TEST CIRCUIT



NOTES ON TESTING AND SPECIFICATIONS

- Note 1 C_C and C_T are measured using a capacitance bridge (Boonton Electronics Model 75A or equivalent).
- Note 2 Noise figure measured with diode under test in tuned diode mount using UHF noise source and local oscillator (LO) frequency of 1.0 GHz. The LO power is adjusted for 1.0 mW. IF amplifier NF = 1.5 dB, f = 30 MHz, see Figure 5.
- Note 3 L_S is measured on a package having a short instead of a die, using an impedance bridge (Boonton Radio Model 250A RX Meter).

SILICON HOT-CARRIER DIODE (SCHOTTKY BARRIER DIODE)

... designed primarily for high-efficiency UHF and VHF detector applications. Readily adaptable to many other fast switching RF and digital applications. Supplied in an inexpensive plastic package for low-cost, high-volume consumer and industrial/commercial requirements. Also available in Surface Mount package.

- The Schottky Barrier Construction Provides Ultra-Stable Characteristics By Eliminating the "Cat-Whisker" or "S-Bend" Contact
- Extremely Low Minority Carrier Lifetime 15 ps (Typ)
- Very Low Capacitance 1.5 pF (Max) @ V_R = 15 V
- Low Reverse Leakage I_R = 13 nAdc (Typ) MBD301, MMBD301

MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

		MBD301	MMBD301LT1	
Rating	Symbol	7	Value	Unit
Reverse Voltage	VR		30	Volts
Forward Power Dissipation @ TA = 25°C Derate above 25°C	a.o PF I	280 2.8	200 2.0	mW mW/°C
Operating Junction Temperature Range	TJ	- 5	55 to +125	°C
Storage Temperature Range	T _{stg}	-5	55 to +150	°C

MBD301* MMBD301LT1*

CASE 182-02, STYLE 1 (TO-226AC)

2 O O 1 Cathode Anode

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)

3 O O 1

30 VOLTS
SILICON HOT-CARRIER
DETECTOR AND SWITCHING
DIODES

★These are Motorola designated preferred devices.

DEVICE MARKING

MMBD301LT1 = 4T

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 µA)	V _{(BR)R}	30	-	1-1	Volts
Total Capacitance, Figure 1 (V _R = 15 Volts, f = 1.0 MHz)	СТ		0.9	1.5	pF
Minority Carrier Lifetime, Figure 2 (I _F = 5.0 mA, Krakauer Method)	τ	-	15		ps
Reverse Leakage, Figure 3 (V _R = 25 V)	IR		13	200	nAdc
Forward Voltage, Figure 4 (I _F = 1.0 mAdc)	6.5 VF	15 -	0.38	0.45	Vdc
Forward Voltage, Figure 4 (I _F = 10 mAdc)	VF		0.52	0.6	Vdc

MMBD301LT1 is also available in bulk packaging. Use MMBD301L as the device title to order this device in bulk.



TYPICAL ELECTRICAL CHARACTERISTICS



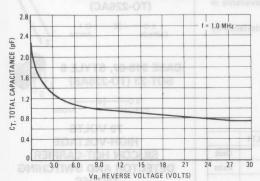


FIGURE 2 — MINORITY CARRIER LIFETIME

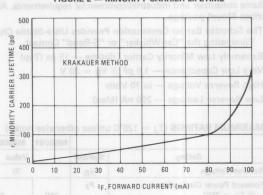


FIGURE 3 — REVERSE LEAKAGE

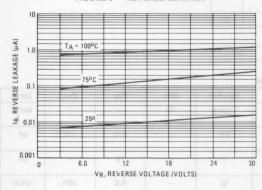
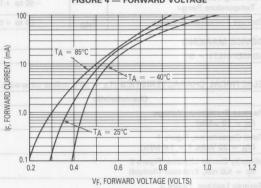
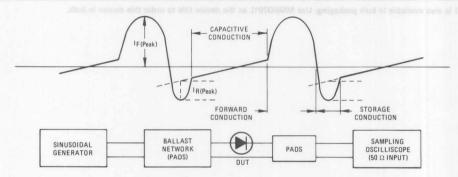


FIGURE 4 — FORWARD VOLTAGE



KRAKAUER METHOD OF MEASURING LIFETIME



SILICON HOT-CARRIER DIODE (SCHOTTKY BARRIER DIODE)

... designed primarily for high-efficiency UHF and VHF detector applications. Readily adaptable to many other fast switching RF and digital applications. Supplied in an inexpensive plastic package for low-cost, high-volume consumer and industrial/commercial requirements. Also available in Surface Mount package.

- The Schottky Barrier Construction Provides Ultra-Stable Characteristics by Eliminating the "Cat-Whisker" or "S-Bend" Contact
- Extremely Low Minority Carrier Lifetime 15 ps (Typ)
- Very Low Capacitance 1.0 pF @ V_R = 20 V
- High Reverse Voltage to 70 Volts
- Low Reverse Leakage 200 nA (Max)

MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

		MBD701	MMBD701LT1	
Rating	Symbol		Value	Unit
Reverse Voltage	V _R	iii (70	Volts
Forward Power Dissipation @ T _A = 25°C Derate above 25°C	aga ar PF	280 2.8	200 2.0	mW mW/°C
Operating Junction Temperature Range	_ \ arTjon	- 5	55 to +125	°C
Storage Temperature Range	T _{stg}	-6	55 to +150	°C

MBD701*
MMBD701LT1*

CASE 182-02, STYLE 1 (TO-226AC)

> 2 O O 1 Cathode Anode

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)

> 3 O O 1 Cathode Anode

70 VOLTS
HIGH-VOLTAGE
SILICON HOT-CARRIER
DETECTOR AND SWITCHING
DIODES

★These are Motorola designated preferred devices.

DEVICE MARKING

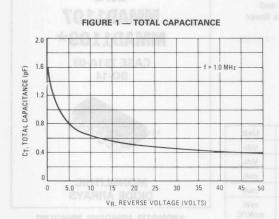
MMBD701LT1 = 5H

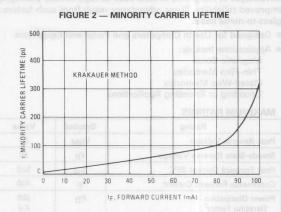
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

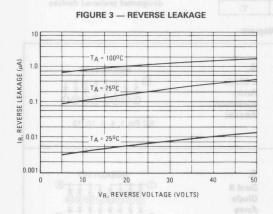
Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 µAdc)	V _{(BR)R}	70		100	Volts
Total Capacitance, Figure 1 (V _R = 20 Volts, f = 1.0 MHz)	c _T		0.5	1.0	pF
Minority Carrier Lifetime, Figure 2 (I _F = 5.0 mA, Krakauer Method)	τ μ	To de de la company de la comp	15	0.0	ps
Reverse Leakage, Figure 3 (V _R = 35 V)	IR	-	9.0	200	nAdc
Forward Voltage, Figure 4 (I _F = 1.0 mAdc)	V _F	-	0.42	0.5	Vdc
Forward Voltage, Figure 4 (I _F = 10 mAdc)	IO WAMVE BUA	KRAI	0.7	1.0	Vdc

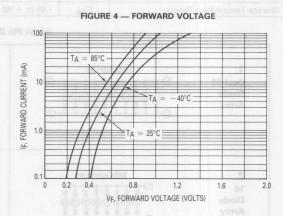
MMBD701LT1 is also available in bulk packaging. Use MMBD701L as the device title to order this device in bulk.

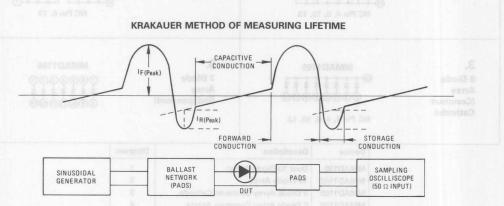
TYPICAL ELECTRICAL CHARACTERISTICS











SURFACE MOUNT DIODE ARRAYS

These diode arrays are multiple diode junctions fabricated by a planar process and mounted in integrated circuit packages for use in high-current, fast-switching core-driver applications. These arrays offer many of the advantages of integrated circuits such as high-density packaging and improved reliability. These advantages result from such factors as fewer glass-to-metal seals.

- Designed for Use in Computers and Peripheral Equipment
- Applications Include:
 Magnetic Cores
 Thin-Film Memories
 Plated-Wire Memories

Decoding or Encoding Applications

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Peak Reverse Voltage	V _{RM}	50	Vdc
Steady-State Reverse Voltage	VR	50	Vdc
Peak Forward Current 25°C	IFM	500	mA
Continuous Forward Current	O OIF	400	mA
Power Dissipation Derating Factor	PD	500 4.0	mW mW/°C
Operating Temperature	TA	-65 to +125	°C
Storage Temperature Range	T _{stq}	-65 to +150	°C

MMAD130 MMAD1103 thru MMAD1107 MMAD1109*

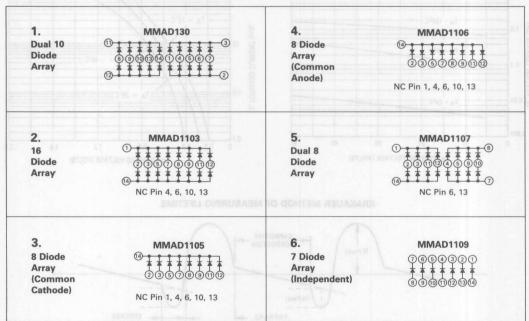
> CASE 751A-03 SO-14



MONOLITHIC DIODE ARRAYS

★MMAD130, MMAD1103, MMAD1107 and MMAD1109 are Motorola designated preferred devices.

SO-14 Pin Diagram



Device	Description	Diagram
MMAD130	Dual 10 Diode Array	1
MMAD1103	16 Diode Array	2
MMAD1105	8 Diode Array Common Cathode	3
MMAD1106	8 Diode Array Common Anode	4
MMAD1107	Dual 8 Diode Array	5
MMAD1109	7 Diode Array	6

ELECTRICAL CHARACTERISTICS (@ 25°C Free-Air Temperature)

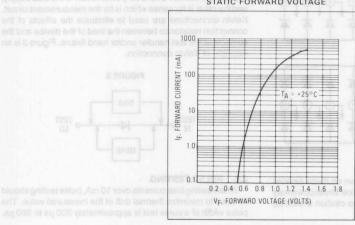
			Limit		3H .0.E
Characteristic		Symbol	Min	Max	Unit
Reverse Breakdown Voltage (1) ($I_R = 10 \mu A$)	tecting any	V(BR)	50	Hoss of david	Vdc
Static Reverse Current (V _R = 40 V)		I _R	n, th <u>e</u> forca	0.1	μΑ
Static Forward Voltage (I _F = 100 mA) (I _F = 500 mA) (2)	As in rigure Las (he high	V _F	and 14. This	1.2 1.6	Vdc
Peak Forward Voltage (3) (IF = 500 mA)	topon of riols	V _{FM}	nairmaist nom	5.0	Vdc

SWITCHING CHARACTERISTICS (@ 25°C Free-Air Temperature)

Characteristic	Symbol	Typical Value	Unit
Forward Recovery Time (I _F = 500 mA)	tfr	20	ns
Reverse Recovery Time (I _F = 200 mA, I _{RM} = 200 mA, R _I = 100 Ω , I _{rr} = 20 mA)	sloat of a leg e trro elst	met nom 8.0	ns

- 1. This parameter must be measured using pulse techniques. PW = 100 μ s, duty cycle \leq 20%.
- 2. This parameter is measured using pulse techniques. PW = 300 µs, duty cycle ≤ 2.0%. Read time is 90 µs from the leading edge of the pulse.
- 3. The initial instantaneous value is measured using pulse techniques. PW = 150 ns, duty cycle ≤ 2.0%, pulse rise time ≤ 10 ns. The total capacitance shunting the diode is 19 pF maximum and the equipment bandwidth is 80 MHz.

FIGURE 1 — TYPICAL CHARACTERISTICS
STATIC FORWARD VOLTAGE

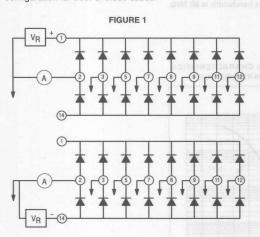


TEST PROCEDURE FOR MULTIPLE DIODES

1.0. REVERSE BIAS TESTING

1.1. LEAKAGE

Regardless of device configuration type, when testing any reverse bias condition, the forcing power supply must be applied only to the uncommon terminal of the pair. As in Figure 1, this would be pins 1 and 14. This can be referred as the high side of the test circuit. The low side of the test circuit must be connected to the common terminal of the pair which in most testers is where the current measurement is taken. This method is used to eliminate the possibility of degrading the diode in that pair which is not under test. Diode arrays with multiple pairs such as the MAD1103, also have leakage paths in the die between common terminals of the pairs. To isolate the device under test so that the leakage from the other pairs in the package do not affect the test result, the leakage current from the common terminals of the pairs not under test must be shunted to measurement common. Figure 1 shows the test configuration for both of these cases.

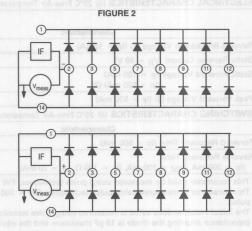


1.2. BREAKDOWN

It is not recommended to test breakdown on these devices due to the possibility of degrading the device. Breakdown may be checked on a curve tracer but extreme caution should be used.

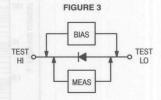
2.0. FORWARD BIAS TESTING

Diode arrays are designed with the pairs in parallel therefore care must be taken to prevent the other diodes in the array from affecting the measured value of the diode under test. Figure 2 illustrates the proper technique to measure only the correct value of the diode under test.



2.1. KELVIN CONNECTION

To achieve the best possible accuracy when testing bias currents over 10 mA, Kelvin connection to the leads of the device under test is mandatory. True Kelvin connection dictates that two test connections are made directly to the leads of the device. One is for power which is the bias supply, and the other is for sense which is for the measurement circuit. Kelvin connections are used to eliminate the effects of the connection resistance between the lead of the device and the contacts of the test handler and/or hand fixture. Figure 3 is an example of Kelvin connection.



2.2. PULSE TESTING

When testing bias currents over 10 mA, pulse testing should be used to minimize thermal drift of the measured value. The pulse width of a pulse test is approximately 300 µs to 380 µs.

3.0. TESTING PROTOCOL

3.1. TEST TYPES

When testing in sequence all of the electrical characteristics, all reverse bias conditions should be tested before the forward bias conditions are tested.

3.2. BIASING MAGNITUDES

Tests of the same test type should be grouped together with the bias conditions in ascending order. For example:

VF @ 10 mA < 0.6 V

VF @ 50 mA < 0.8 V

VF @ 100 mA < 1 V

VF @ 500 mA < 1.5 V

SURFACE MOUNT ISOLATED 8-DIODE ARRAY

This diode array is a multiple diode junction fabricated by a planar process and mounted in integrated circuit packages for use in high-current, fast-switching core-driver applications. This array offers the advantages of an integrated circuit with high-density packaging and improved reliability. This advantage results from such factors as fewer connections, more uniform device parameters, smaller size, less weight and fewer glass-to-metal seals.

• Designed for use in Computers and Peripheral Equipment

Applications Include: Magnetic Cores
 Thin-Film Memories

Plated-Wire Memories Decoding or Encoding

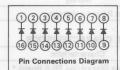
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Peak Reverse Voltage	V _{RM}	50	Vdc
Steady-State Reverse Voltage	VR	50	Vdc
Peak Forward Current 25°C	IFM	500	mA
Continuous Forward Current	IF IF	400	mA
Power Dissipation Derating Factor	PD	500 4.0	mW/°C
Operating Temperature	TA	-65 to +125	°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

MMAD1108*

CASE 751B-05 SO-16





MONOLITHIC DIODE ARRAY

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (@ 25°C Free-Air Temperature)

	Total -65 to +125		enutereLi	mit garage	ine naitonu
Characteristic		Symbol	Min	Max	Unit
Reverse Breakdown Voltage (1) (I _R = 10 µA)		V _(BR)	50	10 x x <u>11</u> x 4.0	Vdc
Static Reverse Current (VR = 40 V)	Ham = (Turaccie)	I _R	LLTTESSEDBM	0.1	μΑ
Static Forward Voltage (I _F = 100 mA) (I _F = 500 mA) (2)	sites estemble and	V _F	_ 	1.20 1.60	Vdc
Peak Forward Voltage (3) (I _F = 500 mA)		V _{FM}	0	5.0	Vdc

SWITCHING CHARACTERISTICS (@ 25°C Free-Air Temperature)

Characteristic	Symbol	Typical Value	Unit
Forward Recovery Time (IF = 500 mA)	t _{fr}	20	ns
Reverse Recovery Time (I _F = 200 mA, I _{RM} = 200 mA, R _L = 100 Ω , i _{rr} = 20 mA)	t _{rr}	8.0	ns ns

1. This parameter must be measured using pulse techniques. PW = 100 μ s, duty cycle \leq 20%.

2. This parameter is measured using pulse techniques. PW = 300 μs, duty cycle ≤ 2.0%. Read time is 90 μs from the leading edge of the pulse.

3. The initial instantaneous value is measured using pulse techniques. PW = 150 ns, duty cycle ≤ 2.0%, pulse rise time ≤ 10 ns. The total capacitance shunting the diode is 19 pF maximum and the equipment bandwidth is 80 MHz.

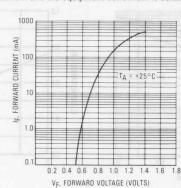


FIGURE 1 — TYPICAL CHARACTERISTICS STATIC FORWARD VOLTAGE

Rev 1

DUAL SILICON HOT-CARRIER DIODES (SCHOTTKY BARRIER DIODES)

... designed primarily for UHF mixer applications. but suitable also for use in detector and ultra-fast switching circuits.

- The Rugged Schottky Barrier Construction Provides Stable Characteristics by Eliminating the "Cat-Whisker" Contact
- Very Low Capacitance Less Than 1.0 pF @ Zero Volts
- Low Forward Voltage 0.5 Volts (Typ) @ IF = 10 mA

MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	VR	Mat. 7.0	Vcc

THERMAL CHARACTERISTICS

Characteristic	Symbol	A. Max	Unit
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C	PD	225	mW
Derate above 25°C		Wm 1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	TJ, T _{stg}	-55 to +125	°C

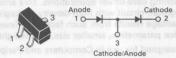
^{*}FR-5 = 1.0 x 0.75 x 0.062 in.

DEVICE MARKING

MMBD352LT1 = M5G; MMBD353LT1 = M4F; MMBD354LT1 = M6H

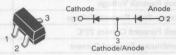
MMBD352LT1*

CASE 318-07, STYLE 11 SOT-23 (TO-236AB)



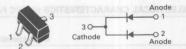
MMBD353LT1*

CASE 318-07, STYLE 19 SOT-23 (TO-236AB)



MMBD354LT1*

CASE 318-07, STYLE 9 SOT-23 (TO-236AB)



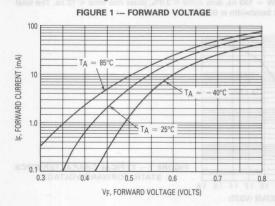
DUAL HOT CARRIER MIXER DIODES

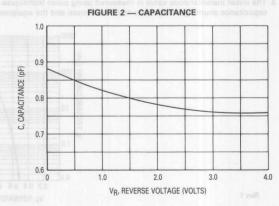
★These are Motorola designated preferred devices.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) (EACH DIODE)

	Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	Inv	steronomo T. viA. oural 1930 o	an same in	TOARAND:	SEGNATION
Forward Voltage (IF = 10 mA)	Symbol	VF	Cha	0.60	V
Reverse Voltage Leakage Current (V _R = 3.0 V)	The state of the s	IR		0.25	μΑ
$(V_R = 7.0V)$ 0.8	117		-	emi10 nevi	verse Red
Capacitance (V _R = 0 V, f = 1.0 MHz)	= 100 µs, duty cycle < 20%,	ng pulse techniques. PW	U m <u>A.</u> Mg = neasured uni	1.0	pF

MMBD352LT1, MMBD353LT1 and MMBD354LT1 are also available in bulk packaging. Use MMBD352L, MMBD353L or MMBD354L as the device title when ordering these devices in bulk.





^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	VR	70	Vdc
Forward Current	l _F	200	mAdc
Peak Forward Surge Current	IFM(surge)	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
	-		
Total Device Dissipation FR-5 Board,* $T_A = 25^{\circ}C$	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

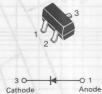
^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBD914LT1 = 5D

MMBD914LT1*

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)



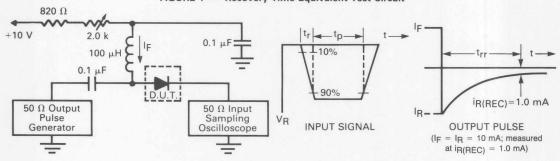
HIGH-SPEED SWITCHING DIODE

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	MANUAL - ESHULIN	Symbol	Min	Max	Unit
OFF CHARACTERISTICS		88.0			
Reverse Breakdown Voltage (I _R = 100 μAdc)		V _(BR)	100	-	Vdc
Reverse Voltage Leakage Current (V _R = 20 Vdc) (V _R = 75 Vdc)		IR	_	25 5.0	nAdc μAdc
Diode Capacitance (V _R = 0, f = 1.0 MHz)		CT		4.0	pF
Forward Voltage (I _F = 10 mAdc)		V _F	-	1.0	Vdc
Reverse Recovery Time (I _F = I _R = 10 mAdc) (Figure 1)		t _{rr}	-	4.0	ns

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (IF) of 10 mA.

- 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
- 3. tp » trr

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

MMBD914LT1



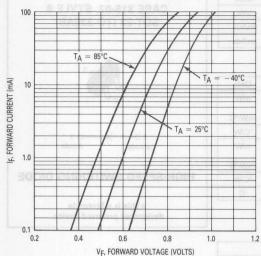
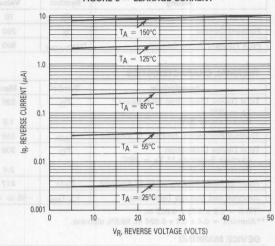
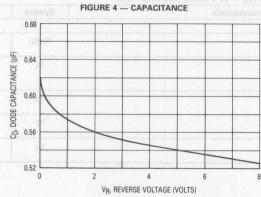


FIGURE 3 — LEAKAGE CURRENT





MAXIMUM RATINGS (EACH DIODE)

Rati	ng	Symbol	Value	Unit
Reverse Voltage	MMBD2836LT1 MMBD2835LT1	VR	75 35	Vdc
Forward Current		IF.	100	mAdd

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* Τ _Δ = 25°C Derate above 25°C	PD	225	mW/°C
Derate above 25 C		1.8	mvv/C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

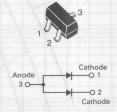
^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBD2835LT1 = A3; MMBD2836LT1 = A2

MMBD2835LT1 MMBD2836LT1

CASE 318-07, STYLE 12 SOT-23 (TO-236AB)

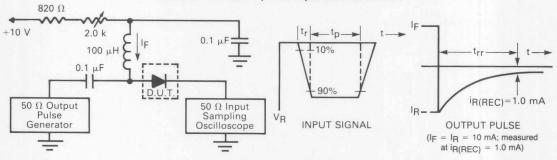


MONOLITHIC DUAL SWITCHING DIODES

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) (EACH DIODE)

Characteri	stic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	30304[10]1100-0-0-01000		- 11-1-11		
Reverse Breakdown Voltage (I _R = 100 μAdc)	MMBD2835LT1 MMBD2836LT1	V _(BR)	35 75		Vdc
Reverse Voltage Leakage Current (V _R = 30 Vdc) (V _R = 50 Vdc)	MMBD2835LT1 MMBD2836LT1	I _R	-	100 100	nAdc
Diode Capacitance (V _R = 0, f = 1.0 MHz)		C _T	-	4.0	pF
Forward Voltage (I _F = 10 mAdc) (I _F = 50 mAdc) (I _F = 100 mAdc)		V _F		1.0 1.0 1.2	Vdc
Reverse Recovery Time (I _F = I _R = 10 mAdc, $i_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t _{rr} at 0	_	4.0	ns

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (I_F) of 10 mA.

- 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
- 3. tp » trr

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

MMBD2835LT1 MMBD2836LT1

1.0

0.1

0.2

0.4

0.6

0.8 V_F, FORWARD VOLTAGE (VOLTS)

Curves Applicable to each Cathode



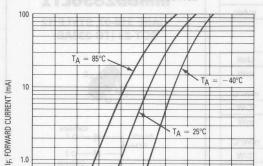


FIGURE 3 — LEAKAGE CURRENT

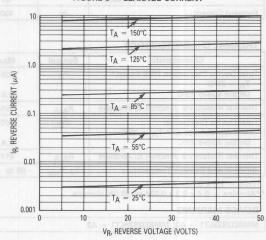
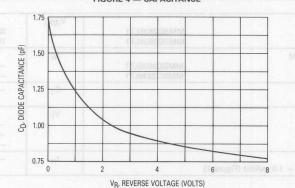


FIGURE 4 — CAPACITANCE



5-74

MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Peak Reverse Voltage	V _{RM}	75	Vdc
D.C. Reverse Voltage MMBD2837L MMBD2838L	. 11	30 50	Vdc
Peak Forward Current	IFM	450 300	mAdo
Average Rectified Current	Io	150 100	mAdo

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	TJ, T _{sta}	-55 to +150	°C

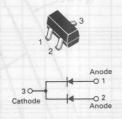
^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBD2837LT1 = A5; MMBD2838LT1 = MA6

MMBD2837LT1 MMBD2838LT1

CASE 318-07, STYLE 9 SOT-23 (TO-236AB)

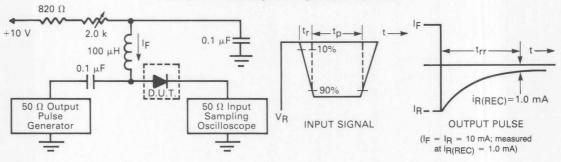


MONOLITHIC DUAL SWITCHING DIODES

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.) (EACH DIODE)

Characteri	stic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS		100			
Reverse Breakdown Voltage (I _(BR) = 100 μAdc)	MMBD2837LT1 MMBD2838LT1	V(BR)	35 75	=	Vdc
Reverse Voltage Leakage Current (V _R = 30 Vdc) (V _R = 50 Vdc)	MMBD2837LT1 MMBD2838LT1	I _R	-	0.1 0.1	μAdc
Diode Capacitance (V _R = 0, f = 1.0 MHz)		СТ		4.0	pF
Forward Voltage (IF = 10 mAdc) (IF = 50 mAdc) (IF = 100 mAdc)		VF	Ξ	1.0 1.0 1.2	Vdc
Reverse Recovery Time (IF = IR = 10 mAdc, $i_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t _{rr}		4.0	ns

FIGURE 1 — Recovery Time Equivalent Test Circuit



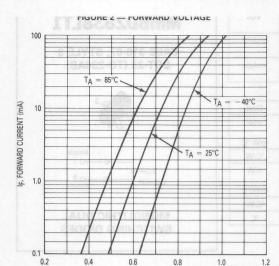
Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (IF) of 10 mA.

2. Input pulse is adjusted so IR(peak) is equal to 10 mA.

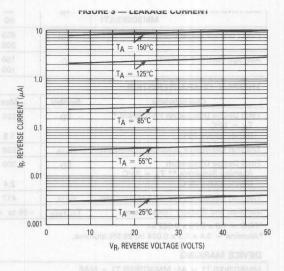
3. tp » trr

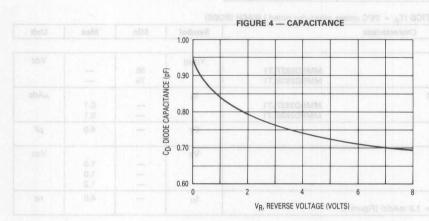
Rev 1

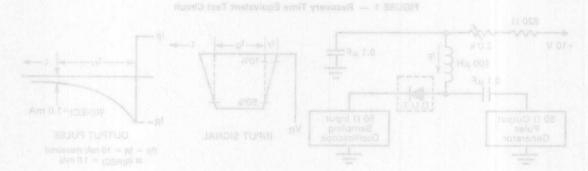
^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.



VF, FORWARD VOLTAGE (VOLTS)







MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	VR	70	Vdc
Forward Current	IF.	200	mAdc
Peak Forward Surge Current	IFM(surge)	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	417	°C/W
Junction and Storage Temperature	TJ, Tstg	-55 to +150	°C

^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

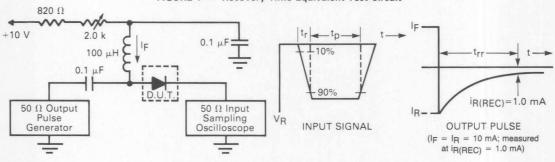
DEVICE MARKING

MMBD6050LT1 = 5AM

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage (I _(BR) = 100 μAdc)	V(BR)	70	_	Vdc
Reverse Voltage Leakage Current (V _R = 50 Vdc)	I _R	a -	0.1	μAdc
Forward Voltage (IF = 1.0 mAdc) (IF = 100 mAdc)	VF	0.55 0.85	0.7 1.1	Vdc
Reverse Recovery Time $(I_F = I_R = 10 \text{ mAdc}, I_R(REC) = 1.0 \text{ mAdc})$ (Figure 1)	t _{rr}	900	4.0	ns
Capacitance (V _R = 0)	С	8 -	2.5	pF

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 $k\Omega$ variable resistor adjusted for a Forward Current (IF) of 10 mA.

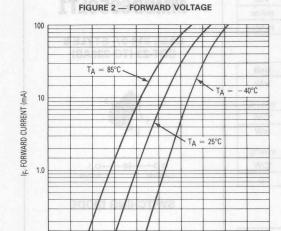
- 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
- 3. tp » trr

^{**}Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.

MMBD6050LT1

0.1

0.4



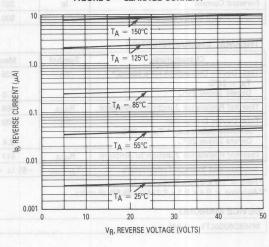
0.6

V_F, FORWARD VOLTAGE (VOLTS)

0.8

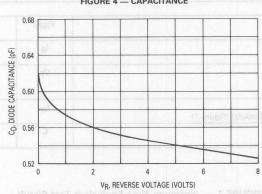
1.0

FIGURE 3 — LEAKAGE CURRENT





1.2



MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	VR	70	Vdc
Forward Current	l _E	200	mAdc
Peak Forward Surge Current	IFM(surge)	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C Derate above 25°C	PD	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, T _{sta}	-55 to +150	°C

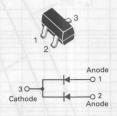
^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBD6100LT1 = 5BM

MMBD6100LT1

CASE 318-07, STYLE 9 SOT-23 (TO-236AB)

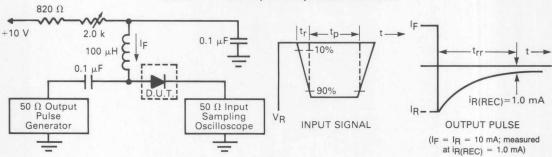


MONOLITHIC DUAL SWITCHING DIODE

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) (EACH DIODE)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	RUDR			
Reverse Breakdown Voltage (I _(BR) = 100 μAdc)	V _(BR)	70	-	Vdc
Reverse Voltage Leakage Current (V _R = 50 Vdc)	I _R	-	0.1	μAdo
Forward Voltage (IF = 1.0 mAdc) (IF = 100 mAdc)	V _F	0.55 0.85	0.7 1.1	Vdc
Reverse Recovery Time (IF = IR = 10 mAdc, iR(REC) = 1.0 mAdc) (Figure 1)	t _{rr}	-	4.0	ns
Capacitance (V _R = 0)	C 00.8	5 -	2.5	pF

FIGURE 1 — Recovery Time Equivalent Test Circuit

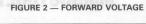


Notes: 1. A 2.0 $k\Omega$ variable resistor adjusted for a Forward Current (IF) of 10 mA.

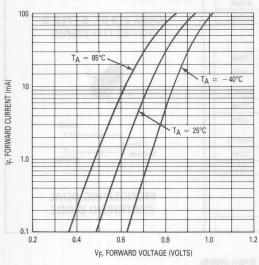
- 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
- 3. tp » trr

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Curves Applicable to each Anode







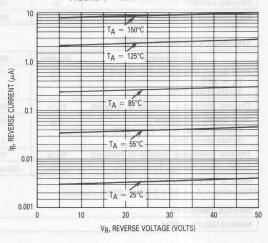
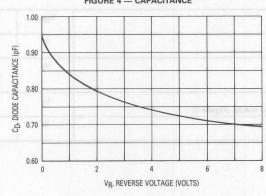


FIGURE 4 — CAPACITANCE



MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	VR	100	Vdc
Forward Current	l _F	200	mAdc
Peak Forward Surge Current	IFM(surge)	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* TA = 25°C	PD	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta}JA$	556	°C/W
Total Device Dissipation Alumina Substrate,** T _A = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	TJ, Tsta	-55 to +150	°C

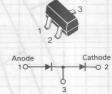
^{*}FR-5 = $1.0 \times 0.75 \times 0.062$ in.

DEVICE MARKING

MMBD7000LT1 = M5C

MMBD7000LT1*

CASE 318-07, STYLE 11 SOT-23 (TO-236AB)



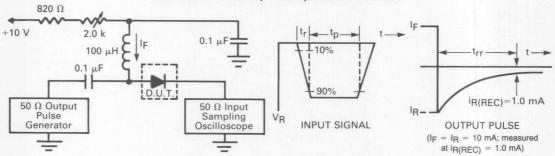
DUAL SWITCHING DIODE

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) (EACH DIODE)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	FIGURE 4 — CAPA	THE P		
Reverse Breakdown Voltage (I(BR) = 100 µAdc)	V(BR)	100	-	Vdc
Reverse Voltage Leakage Current (V _R = 50 Vdc) (V _R = 100 Vdc) (V _R = 50 Vdc, 125°C)	R R2 R3	Ξ	1.0 3.0 100	μAdc
Forward Voltage (I _F = 1.0 mAdc) (I _F = 10 mAdc) (I _F = 100 mAdc)	V _E	0.55 0.67 0.75	0.7 0.82 1.1	Vdc
Reverse Recovery Time (I _F = I _R = 10 mAdc) (Figure 1)	t _{rr}	_	4.0	ns
Capacitance (V _R = 0)	C	-	1.5	pF

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 $k\Omega$ variable resistor adjusted for a Forward Current (IF) of 10 mA.

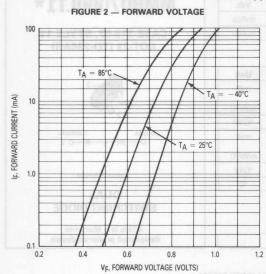
2. Input pulse is adjusted so IR(peak) is equal to 10 mA.

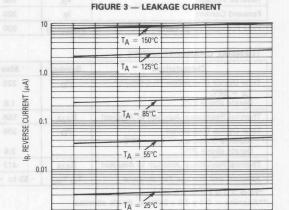
3. tp » trr

^{**}Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

MMBD7000LT1

Curves Applicable to each Diode





20

30

V_R, REVERSE VOLTAGE (VOLTS)

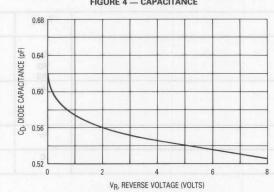
40

FIGURE 4 — CAPACITANCE

0.001

0

10



SILICON EPICAP DIODE

... designed in the Surface Mount package for general frequency control and tuning applications; providing solid-state reliability in replacement of mechanical tuning methods.

• Controlled and Uniform Tuning Ratio

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	VR	30	Volts
Forward Current	IF	200	mA
Device Dissipation @ T _A = 25°C Derate above 25°C	PD	200 2.0	mW/°C
Junction Temperature	TJ	+ 125	°C
Storage Temperature Range	T _{sta}	-55 to +150	°C

DEVICE MARKING

MMBV105GLT1 = M4E

MMBV105GLT1*

PTIDEOFVERM

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)



3 O 0 1 Cathode Anode

30 VOLT VOLTAGE VARIABLE CAPACITANCE DIODE

★This is a Motorola designated preferred device.

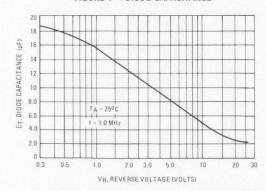
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Reverse Breakdown Voltage (I _R = 10 μAdc)	V(BR)R	30	L	Vdc
Reverse Voltage Leakage Current (VR = 28 V)	IR		50	nAdc

Device Type		T c, f = 1.0 MHz oF	Q f = 50 MHz V _R = 3.0 V	f = 1.	R 0 MHz C ₂₅
	Min	Max	Тур	Min	Max
MMBV105GLT1	1.5	2.8	250	4.0	6.5

MMBV105GLT1 is also available in bulk packaging. Use MMBV105GL as the device title to order this device in bulk.

FIGURE 1 — DIODE CAPACITANCE



Rev 1

MMBV105GLT1

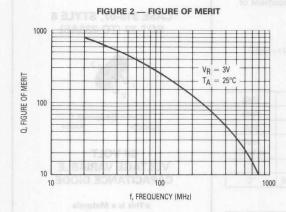
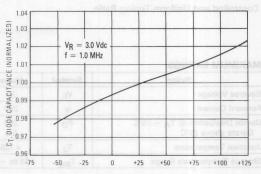
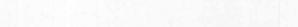


FIGURE 3 — DIODE CAPACITANCE



TA, AMBIENT TEMPERATURE (°C)





SILICON EPICAP DIODES

... designed for general frequency control and tuning applications; providing solid-state reliability in replacement of mechanical tuning methods.

- High Q with Guaranteed Minimum Values at VHF Frequencies
- Controlled and Uniform Tuning Ratio
- Available in Surface Mount Package

MAXIMUM RATINGS

		MV209	MMBV109LT1	
Rating	Symbol		Value	Unit
Reverse Voltage	VR		30	Volts
Forward Current	IF		200	mA
Forward Power Dissipation @ T _A = 25°C Derate above 25°C	PD	280 2.8	200 2.0	mW mW/°C
Junction Temperature	TJ		+ 125	°C
Storage Temperature Range	T _{stg}	-!	55 to +150	°C

DEVICE MARKING

MMBV109LT1 = M4A

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

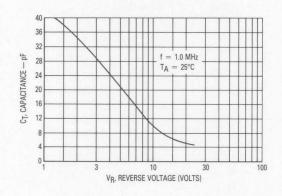
Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 μAdc)	V(BR)R	30	20 V 0	U - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	Vdc
Reverse Voltage Leakage Current (V _R = 25 Vdc)	IR		N.	0.1	μAdc
Diode Capacitance Temperature Coefficient (V _R = 3.0 Vdc, f = 1.0 MHz)	TCC	T	300		ppm/°C

	C _t , Diode Capacitance V _R = 3.0 Vdc, f = 1.0 MHz pF		Q, Figure of Merit VR = 3.0 Vdc f = 50 MHz	C ₃ /	tance Ratio C ₂₅ 0 MHz	
Device	Min	Nom	Max	Min	Min	Max
MMBV109LT1, MV209	26	29	32	200	5.0	6.5

⁽¹⁾ C_R is the ratio of C_t measured at 3 Vdc divided by C_t measured at 25 Vdc.

MMBV109LT1 is also available in bulk packaging. Use MMBV109L as the device title to order this device in bulk.

FIGURE 1 — DIODE CAPACITANCE



Rev 1

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)





CASE 182-02, STYLE 1 (TO-226AC)





26–32 pF VOLTAGE VARIABLE CAPACITANCE DIODES

★These are Motorola designated preferred devices.

MMBV109LT1 MV209



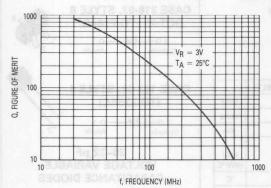


FIGURE 3 — LEAKAGE CURRENT

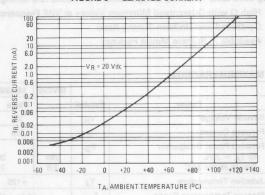
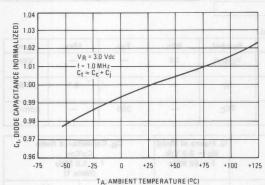


FIGURE 4 — DIODE CAPACITANCE



NOTES ON TESTING AND SPECIFICATIONS

1. C_R is the ratio of C_t measured at 3.0 Vdc divided by C_t measured at 25 Vdc.

5-86

SILICON EPICAP DIODES

... designed for general frequency control and tuning applications; providing solid-state reliability in replacement of mechanical tuning methods.

- High Q with Guaranteed Minimum Values at VHF Frequencies
- Controlled and Uniform Tuning Ratio
- Available in Surface Mount Package

MAXIMUM RATINGS

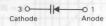
		MV409	MMBV409LT1	
Rating	Symbol		Value	Unit
Reverse Voltage	VR		20	Volts
Forward Current	IF		200	mA
Forward Power Dissipation @ T _A = 25°C Derate above 25°C	PD	280 2.8	200	mW mW/°C
Junction Temperature	TJ		+ 125	°C
Storage Temperature Range	T _{stg}		55 to +150	°C

DEVICE MARKING

MMBV409LT1 = X5

MMBV409LT1* MV409*

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)



1 2 3

CASE 182-02, STYLE 1 TO-92 (TO-226AC)





VOLTAGE VARIABLE CAPACITANCE DIODES

★These are Motorola designated preferred devices.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Characteristic — All Types	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 μAdc)	V _{(BR)R}	20	10V e1 =	HA -	Vdc
Reverse Voltage Leakage Current (V _R = 15 Vdc)	IR		-	0.1	μAdc
Diode Capacitance Temperature Coefficient (VR = 3 Vdc, f = 1 MHz)	TCC		300		ppm/°C

-35 0 +25 +50 +35 +100 +125 Y _A , AMDIEN TEMBERATURE PC)	C _t , Diode Capacitance V _R = 3 Vdc, f = 1 MHz pF		Q, Figure of Merit VR = 3 Vdc f = 50 MHz	C _R , Capacitance Ratio C ₃ /C ₈ f = 1 MHz (Note 1)		
Device	Min	Nom	Max	Min	Min	Max
MMBV409LT1, MV409	26	29	32	200	1.5	1.9

NOTES ON TESTING AND SPECIFICATIONS

(1) C_R is the ratio of C_t measured at 3 Vdc divided by C_t measured at 8 Vdc.

MMBV409LT1 is also available in bulk packaging. Use MMBV409L as the device title to order this device in bulk.

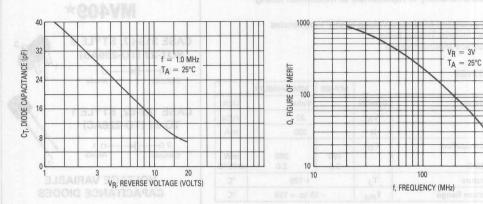


Figure 1. Diode Capacitance

Figure 2. Figure of Merit

1000

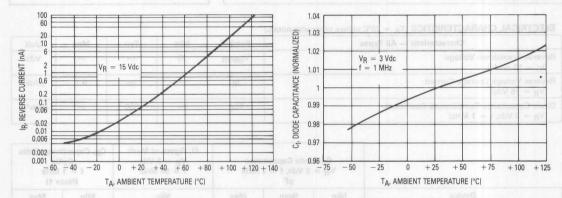


Figure 3. Leakage Current

Figure 4. Diode Capacitance

SILICON EPICAP DIODE

... designed for FM tuning, general frequency control and tuning, or any top-of-the-line application requiring back-to-back diode configuration for minimum signal distortion and detuning. This device is supplied in the SOT-23 plastic package for high volume, pick and place assembly requirements.

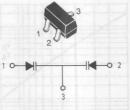
- High Figure of Merit Q = 150 (Typ) @ $V_R = 2.0$ Vdc, f = 100 MHz
- Guaranteed Capacitance Range
- Dual Diodes Save Space and Reduce Cost
- Surface Mount Package
- Available in 8 mm Tape and Reel
- Monolithic Chip Provides Improved Matching Guaranteed ±1.0% (Max)
 Over Specified Tuning Range

MAXIMUM RATINGS (Each Diode)

Rating	Symbol	Value	Unit
Reverse Voltage	VR	14	Volts
Forward Current	IF.	200	mA
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PD	350 2.8	mW mW/°C
Junction Temperature	TJ	+125	°C
Storage Temperature Range	T _{stg}	-55 to +125	°C

MMBV432LT1*

CASE 318-07, STYLE 9 SOT-23 (TO-236AB)



DUAL VOLTAGE-VARIABLE CAPACITANCE DIODE

★This is a Motorola designated preferred device.

DEVICE MARKING

MMBV432LT1 = M4B

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) (EACH DIODE)

Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 µAdc)	V(BR)R	14	-		Vdc
Reverse Voltage Leakage Current (V _R = 9.0 Vdc)	I _R	1 00		100	nAdc
Diode Capacitance (V _R = 2.0 Vdc, f = 1.0 MHz)	СТ	43	-	48.1	pF
Capacitance Ratio C2/C8 (f = 1.0 MHz)	CR	1.5		2.0	-
Figure of Merit (V _R = 2.0 Vdc, f = 100 MHz)	Q	100	150	-	

MMBV432LT1 is also available in bulk packaging. Use MMBV432L as the device title to order this device in bulk.

TYPICAL CHARACTERISTICS (Each Diode)

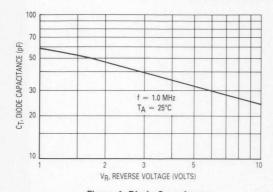


Figure 1. Diode Capacitance

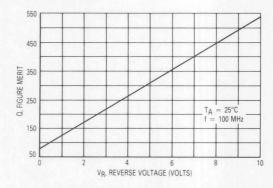


Figure 2. Figure of Merit versus Voltage

Rev 1

TYPICAL CHARACTERISTICS (Each Diode)

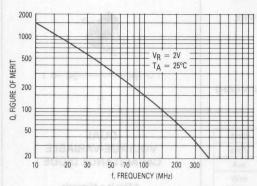


Figure 3. Figure of Merit versus Frequency

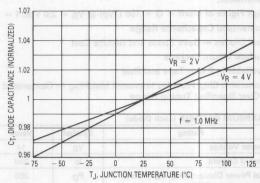


Figure 4. Diode Capacitance versus Temperature

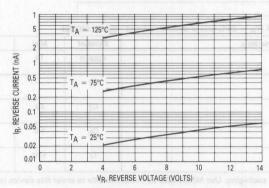
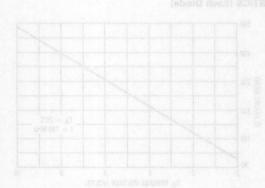
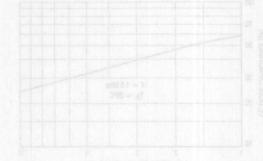


Figure 5. Reverse Current versus Reverse Voltage





SILICON EPICAP DIODE

... designed for FM tuning, general frequency control and tuning, or any top-of-the-line application requiring back-to-back diode configuration for minimum signal distortion and detuning. This device is supplied in the SOT-23 plastic package for high volume, pick and place assembly requirements.

- High Figure of Merit Q = 450 (Typ) @ V_R = 3.0 Vdc, f = 50 MHz
- Guaranteed Capacitance Range
- Dual Diodes Save Space and Reduce Cost
 Surface Mount Package
- Available in 8 mm Tape and Reel
- Monolithic Chip Provides Improved Matching
- Hyper Abrupt Junction Process Provides High Tuning Ratio

MAXIMUM RATINGS (Each Diode)

Rating	Symbol	Value	Unit
Reverse Voltage	VR	20	Volts
Forward Current	l _F	100	mA
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PD	225 1.8	mW/°C
Junction Temperature	TJ	+ 125	°C
Storage Temperature Range	T _{sta}	-55 to +125	°C

MMBV609LT1*

CASE 318-07, STYLE 9 SOT-23 (TO-236AB)



DUAL **VOLTAGE-VARIABLE** CAPACITANCE DIODE

★This is a Motorola designated preferred device.

DEVICE MARKING

MMBV609LT1 = 5L

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.) (EACH DIODE)

Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 μAdc)	V _{(BR)R}	20		_	Vdc
Reverse Voltage Leakage Current (V _R = 15 Vdc)	IR	Die S		10	nAdc
Diode Capacitance (V _R = 3.0 Vdc, f = 1.0 MHz)	CT	26	-	32	pF
Capacitance Ratio C3/C8 (f = 1.0 MHz)	CR	1.8	-	2.4	-
Figure of Merit (V _R = 3.0 Vdc, f = 50 MHz)	es Q 18-	250	450	-	-

MMBV609LT1 is also available in bulk packaging. Use MMBV609L as the device title to order this device in bulk.

TYPICAL CHARACTERISTICS — EACH DIODE

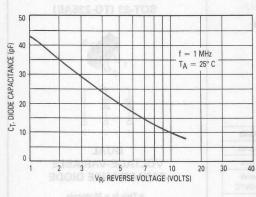


Figure 1. Diode Capacitance

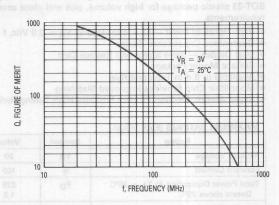


Figure 2. Figure of Merit

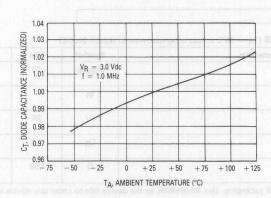


Figure 3. Diode Capacitance

SILICON EPICAP DIODE

... designed for 900 MHz frequency control and tuning applications; providing solid-state reliability in replacement of mechanical tuning methods.

- Controlled and Uniform Tuning Ratio
- Available in Surface Mount Package
- Available in 8 mm Tape and Reel

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	VR	20	Volts
Forward Current	IF	20	mA
Forward Power Dissipation @ T _A = 25°C Derate above 25°C	PD	225* 1.8	mW mW/°C
Junction Temperature	TJ	+ 125	Or °C
Storage Temperature Range	T _{stg}	-55 to +125	°C

^{*}FR5 Board 1.0 \times 0.75 \times 0.62 in.

DEVICE MARKING

MMBV809LT1 = 5K

MMBV809LT1*

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)



1 O CATHODE

VOLTAGE VARIABLE CAPACITANCE DIODE 4.5–6.1 pF

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic — All Types	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 µAdc)	V _{(BR)R}	20	-	-	Vdc
Reverse Voltage Leakage Current (V _R = 15 Vdc)	IR	— (= §	-	50	nAdc

25t + 50t +		= 2.0 Vdc, f = 1.0 MHz		Q, Figure of Merit $V_{R} = 3.0 \text{ Vdc}$ $f = 500 \text{ MHz}$	f = 1.	tance Ratio /C ₈ 0 MHz te 1)
Device	Min	Тур	Max	Тур	Min	Max
MMBV809LT1	4.5	5.3	6.1	75	1.8	2.6

⁽¹⁾ CR is the ratio of Ct measured at 2.0 Vdc divided by Ct measured at 8.0 Vdc.

MMBV809LT1 is also available in bulk packaging. Use MMBV809L as the device title to order this device in bulk.

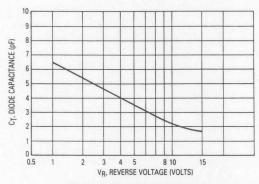


Figure 1. Diode Capacitance

MMBV809LT1

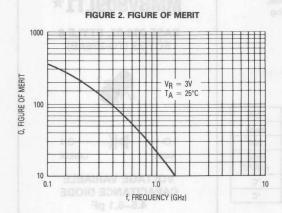


FIGURE 3. SERIES RESISTANCE

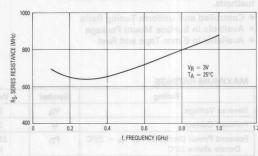
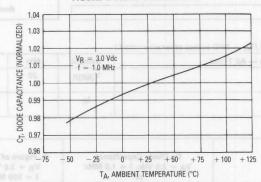


FIGURE 4. DIODE CAPACITANCE





5-94

SILICON EPICAP DIODES

... designed in the popular PLASTIC PACKAGE for high volume requirements of FM Radio and TV tuning and AFC, general frequency control and tuning applications; providing solid-state reliability in replacement of mechanical tuning methods.

Also available in Surface Mount Package up to 33 pF.

- · High Q
- Controlled and Uniform Tuning Ratio
- Standard Capacitance Tolerance 10%
- Complete Typical Design Curves

MAXIMUM RATINGS

	4.5					
8.0 0.8 8.0 3.3		MV21XX	MMBV21XXLT1			
Rating	Symbol	Lightcyni	Value	Unit		
Reverse Voltage	VR	30		Volts		
Forward Current	IF	200		mA		
Forward Power Dissipation @ T _A = 25°C Derate above 25°C	PD	280 2.8	200 2.0	mW mW/°C		
Junction Temperature	TJ	+ 125		°C		
Storage Temperature Range	T _{stg}	-55 to +150		°C		

DEVICE MARKING

	MMBV2101LT1	= M4G	MMBV2105LT1 =	4U	MMBV2109LT1 = 4J
	MMBV2103LT1	= 4H	MMBV2107LT1 =	4W	
1	BARADI (OAOAL TA	47	A AB ADVIOLOGI TA	434	

MMBV2101LT1
MMBV2103LT1 thru
MMBV2105LT1
MMBV2107LT1 thru
MMBV2109LT1*
MV2101
MV2103 thru MV2105
MV2107 thru MV2109
MV2111
MV2113 thru MV2115*

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)



3 O 1 Cathode Anode

CASE 182-02, STYLE 1 (TO-226AC)

20-



6.8–100 pF 30 VOLTS VOLTAGE-VARIABLE

CAPACITANCE DIODES

-0 1

★MMBV2101LT1, MMBV2105LT1, MMBV2109LT1, MV2101, MV2104, MV2108, MV2109, MV2111, MV2113 and MV2115 are Motorola designated preferred devices.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 µAdc)	V _{(BR)R}	30	ollo <u>va</u> ng en 2	i erti <u>ni g</u> ni	Vdc
Reverse Voltage Leakage Current (V _R = 25 Vdc, T _A = 25°C)	I _R	- E	ntrol/center	0.1	μAdc
Diode Capacitance Temperature Coefficient (VR = 4.0 Vdc, f = 1.0 MHz)	TCC	-	280	- 28	ppm/°C

MMBV2101LT1 MMBV2103LT1 thru MMBV2105LT1 MMBV2107LT1 thru MMBV2109LT1 MV2101 MV2103 thru MV2105 MV2107 thru MV2109 MV2111 MV2113 thru MV2115

2109LT1*	C _T , Diode Capacitance V _R = 4.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit VR = 4.0 Vdc, f = 50 MHz	TR, Tuning Ratio C_2/C_{30} $f = 1.0 \text{ MHz}$		
Device	Min	Nom	Max	Тур	Min	Тур	Max
MMBV2101LT1/MV2101	6.1	6.8	7.5	450	2.5	2.7	3.2
MMBV2103LT1/MV2103	9.0	10	11	400	2.5	2.9	3.2
MMBV2104LT1/MV2104	10.8	12	13.2	400	2.5	2.9	3.2
MMBV2105LT1/MV2105	13.5	15	16.5	400	2.5	2.9	3.2
MMBV2107LT1/MV2107	19.8	22	24.2	350	2.5	2.9	3.2
MMBV2108LT1/MV2108	24.3	27	29.7	300	2.5	3.0	3.2
MMBV2109LT1/MV2109	29.7	33	36.3	200	2.5	3.0	3.2
MV2111	42.3	47	51.7	150	2.5	3.0	3.2
MV2113	61.2	68	74.8	150	2.6	3.0	3.3
MV2114	73.8	82	90.2	100	2.6	3.0	3.3
MV2115	90	100	110	100	2.6	3.0	3.3

MMBV2101LT1, MMBV2103LT1 thru MMBV2105LT1 and MMBV2107LT1 thru MMBV2109LT1 are also available in bulk. Use the device title and drop the "T1" suffix when ordering any of these devices in bulk.

PARAMETER TEST METHODS

1. CT, DIODE CAPACITANCE

 $(C_T = C_C + C_J)$, C_T is measured at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

2. TR, TUNING RATIO

TR is the ratio of C_T measured at 2.0 Vdc divided by C_T measured at 30 Vdc.

3. Q. FIGURE OF MERIT

Q is calculated by taking the G and C readings of an admittance bridge at the specified frequency and substituting in the following equations:

$$Q = \frac{2\pi fC}{C}$$

(Boonton Electronics Model 33AS8). Use Lead Length \approx 1/16".

4. TC_C, DIODE CAPACITANCE TEMPERATURE COEFFICIENT

 TC_C is guaranteed by comparing C_T at $V_R=4.0$ Vdc, f=1.0 MHz, $T_A=-65^{\circ}C$ with C_T at $V_R=4.0$ Vdc, f=1.0 MHz, $T_A=+85^{\circ}C$ in the following equation which defines TC_C :

$$TC_{C} = \frac{C_{T}(+85^{\circ}C) - C_{T}(-65^{\circ}C)}{85 + 65} * \frac{10^{6}}{C_{R}(25^{\circ}C)}$$

Accuracy limited by measurement of C_T to \pm 0.1 pF.

MMBV2101LT1 MMBV2103LT1 thru MMBV2105LT1 MMBV2107LT1 thru MMBV2109LT1 MV2101 MV2103 thru MV2105 MV2107 thru MV2109 MV2111 MV2113 thru MV2115

TYPICAL DEVICE PERFORMANCE

FIGURE 1 — DIODE CAPACITANCE versus REVERSE VOLTAGE

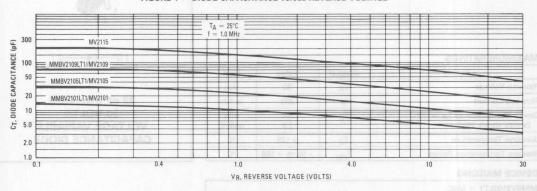


FIGURE 2 — NORMALIZED DIODE CAPACITANCE versus JUNCTION TEMPERATURE

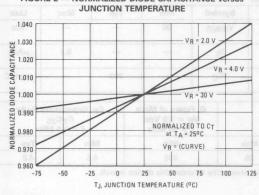


FIGURE 3 — REVERSE CURRENT versus REVERSE

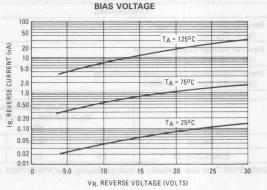


FIGURE 4 — FIGURE OF MERIT versus REVERSE VOLTAGE

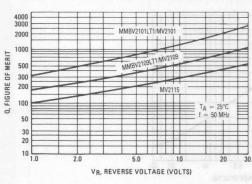
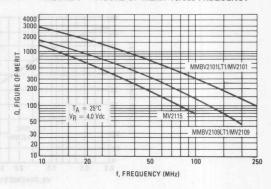


FIGURE 5 — FIGURE OF MERIT versus FREQUENCY



SILICON EPICAP DIODE

... designed in the Surface Mount package for general frequency control and tuning applications; providing solid-state reliability in replacement of mechanical tuning methods.

- High Q with Guaranteed Minimum Values at VHF Frequencies
- Controlled and Uniform Tuning Ratio

MMBV3102LT1

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)



22 pF (Nominal) 30 VOLTS VOLTAGE VARIABLE CAPACITANCE DIODE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	VR	30	Vdc
Forward Current	IF.	200	mAdc
Device Dissipation @ T _A = 25°C Derate above 25°C	PD	200 2.0	mW mW/°C
Junction Temperature	TJ	+ 125	°C
Storage Temperature Range	T _{stg}	-55 to +150	°C

DEVICE MARKING

MMBV3102LT1 = M4C

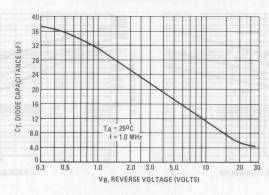
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

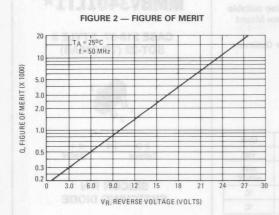
Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 µAdc)	V(BR)R	30	Ť		Vdc
Reverse Voltage Leakage Current (V _R = 25 Vdc, T _A = 25°C)	IR	-	_	0.1	μAdc
Diode Capacitance Temperature Coefficient (V _R = 4.0 Vdc, f = 1.0 MHz)	TCC	A C	300		ppm/°C

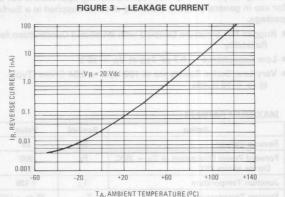
		C _T , Diode Capacitance V _R = 3.0 Vdc, f = 1.0 MHz pF		Q, Figure of Merit VR = 3.0 Vdc, f = 50 MHz	3.0 Vdc, C ₃ /C	
Device	Min	Nom	Max	Min	Min	Тур
MMBV3102LT1	20	22	25	200	4.5	4.8

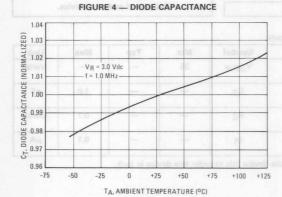
MMBV3102LT1 is also available in bulk packaging. Use MMBV3102L as the device title to order this device in bulk.

FIGURE 1 — DIODE CAPACITANCE



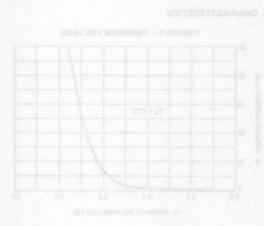


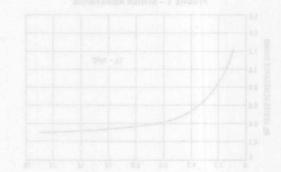




NOTES ON TESTING AND SPECIFICATIONS

1. $C_{\mbox{\scriptsize R}}$ is the ratio of $C_{\mbox{\scriptsize T}}$ measured at 3.0 Vdc divided by $C_{\mbox{\scriptsize T}}$ measured at 25 Vdc.





SILICON PIN DIODE

... designed primarily for VHF band switching applications but also suitable for use in general-purpose switching circuits. Supplied in a Surface Mount package.

- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Capacitance 0.7 pF Typ at V_R = 20 V
- Very Low Series Resistance at 100 MHz 0.34 Ohms (Typ)
 @ IF = 10 mAdc

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	VR	20	Vdc
Forward Power Dissipation @ T _A = 25°C Derate above 25°C	PF	200 2.0	mW mW/°C
Junction Temperature	TJ	+ 125	°C
Storage Temperature Range	T _{stg}	-55 to +150	°C

DEVICE MARKING

MMBV3401LT1 = 4D

MMBV3401LT1*

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)



SILICON PIN SWITCHING DIODE

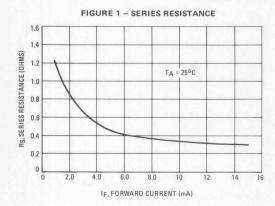
★This is a Motorola designated preferred device.

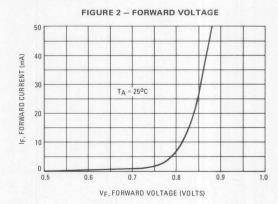
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

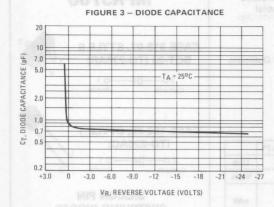
Characteristic MANAGEM	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (IR = 10 μ A)	V _{(BR)R}	35	- 96V - 5H	E = 1 - 1 - 1 - 1 - 1	Volts
Diode Capacitance (V _R = 20 V)	CT		-	1.0	pF
Series Resistance (Figure 5) (IF = 10 mA) f = 100 MHz	RS			0.7	Ohms
Reverse Leakage Current (V _R = 25 V)	IR			0.1	μΑ

MMBV3401LT1 is also available in bulk packaging. Use MMBV3401L as the device title to order this device in bulk.

TYPICAL ELECTRICAL CHARACTERISTICS







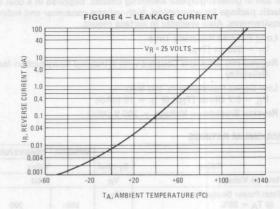
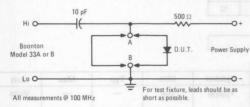


FIGURE 5 - FORWARD SERIES RESISTANCE TEST METHOD



To measure series resistance, a 10 pF capacitor is used to reduce the forward capacitance of the circuit and to prevent shorting of the external power supply through the bridge. The small signal from the bridge is prevented from shorting through the power supply by the 500-ohm resistor. The resistance of the 10 pF capacitor can be considered negligible for this measurement.

1. The RF Admittance Bridge (Boonton 33A or B) must be initially balanced, with the test circuit connected to the bridge test terminals. The conductance scale will be set at zero and the capacitance scale will be set at 120 pF, as required when using the 100 MHz test coil.

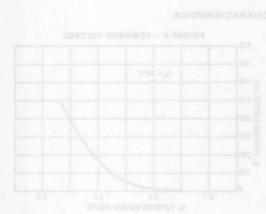
- 2. Use a short length of wire to short the test circuit from point "A" to "B". Then connect the power supply providing 10 mA of bias current to the test circuit.
- 3. Adjust the capacitance scale arm of the bridge and the "G" $\,$ zero control for a minimum null on the "null meter" The null occurs at approximately 130 pF.
- 4. Replace the wire short with the device to be tested. Bias the device to a forward conductance state of 10 mA.
- 5. Obtain a minimum null on the "null meter", with the capacitance and conductance scale adjustment arms.
- 6. Read conductance (G) direct from the scale. Now read the capacitance value from the scale (≈ 130 pF) and subtract 120 pF which yields capacitance (C). The forward resistance (R_S) can now be calculated from:

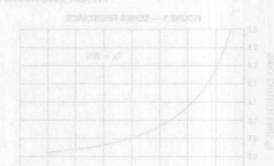
$$R_S = \frac{2.533 \, G}{C^2}$$

Where: G - in micromhos.

C - in pF,

Rs - in ohms





HIGH VOLTAGE SILICON PIN DIODES

... designed primarily for VHF band switching applications but also suitable for use in general-purpose switching circuits. Supplied in a cost effective plastic package for economical, high-volume consumer and industrial requirements. Also available in surface mount.

- Long Reverse Recovery Time $t_{rr} = 300 \text{ ns (Typ)}$
- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Series Resistance @ 100 MHz - $R_S = 0.7 \text{ Ohms (Typ)} @ I_F = 10 \text{ mAdc}$
- Reverse Breakdown Voltage = 200 V (Min)

MAXIMUM RATINGS

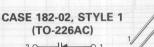
		MPN3700	MMBV3700LT1	
Rating	Symbol		Value	Unit
Reverse Voltage	VR	12-	200	Volts
Total Power Dissipation @ T _A = 25°C Derate above 25°C	P _D	280 2.8	200 2.0	mW mW/°C
Junction Temperature	остуга	I TRET BOI	+125	□ °C
Storage Temperature Range	T _{stg}	-55 to +150		°C

MMBV3700LT1 MPN3700

CASE 318-07, STYLE 8 SOT-23 (TO-236AB)



0 1 Anode



(TO-226AC) 20-Anode Cathode

> SILICON PIN **SWITCHING DIODES**

DEVICE MARKING

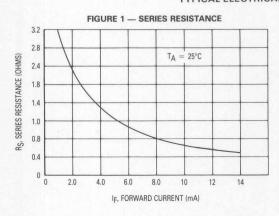
MMBV3700LT1 = 4R

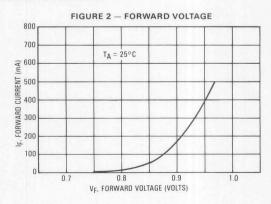
ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

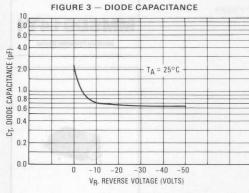
Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (IR = 10 μ A)	V(BR)R	200	_	HAT ON THE STREET	Volts
Diode Capacitance $(V_R = 20 \text{ Vdc}, f = 1.0 \text{ MHz})$	eoute CT beau to mourous to	iei nof le gso il veng bi bris si	g GT i -c onsat policy and to s	1.0	sem pFi
Series Resistance (Figure 5) (IF = 10 mA)	RS	ere geologe. Skortleg thiol he constance	0.7	1.0	Ohms
Reverse Leakage Current (V _R = 150 Vdc)	IR mesta	e for thi s mea Boomson 33A	ered <u>ce</u> gligib ence Bridge	imbA 38 se	μΑ
Reverse Recovery Time (IF = IR = 10 mA)	t _{rr}	nst cr <u>ro</u> uit go stuctioner sed	300	Hally beland idge text term	ns

MMBV3700LT1 is also available in bulk packaging. Use MMBV3700L as the device title to order this device in bulk.

TYPICAL ELECTRICAL CHARACTERISTICS







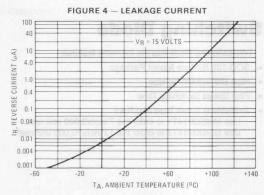
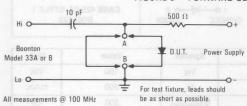


FIGURE 5 — FORWARD SERIES RESISTANCE TEST METHOD



To measure series resistance, a 10 pF capacitor is used to reduce the forward capacitance of the circuit and to prevent shorting of the external power supply through the bridge. The small signal from the bridge is prevented from shorting through the power supply by the 500-ohm resistor. The resistance of the 10 pF capacitor can be considered negligible for this measurement.

The RF Admittance Bridge (Boonton 33A or B) must be initially balanced, with the test circuit connected to the bridge test terminals. The conductance scale will be set at zero and the capacitance scale will be set at 120 pF, as required when using the 100 MHz test coil.

- Use a short length of wire to short the test circuit from point "A" to "B". Then connect the power supply providing 10 mA of bias current to the test circuit.
- Adjust the capacitance scale arm of the bridge and the "G" zero control for a minimum null on the "null meter". The null occurs at approximately 130 pF.
- Replace the wire short with the device to be tested. Bias the device to a forward conductance state of 10 mA.
- Obtain a minimum null on the "null meter", with the capacitance and conductance scale adjustment arms.
- Read conductance (G) direct from the scale. Now read the capacitance value from the scale (≈130 pF) and subtract 120 pF which yields capacitance (C). The forward resistance (Rg) can now be calculated from:

$$R_S = \frac{2.533 \text{ G}}{C^2}$$

Where:

G — in micromhos,

C — in pF,

Rs - in ohms

Switching Diode

This switching diode has the following features:

- SOD-123 Surface Mount Package
- High Breakdown Voltage
- Fast Speed Switching Time
- Available in 8 mm Tape and Reel
 Use MMSD914T1 to order the 7 inch/3,000 unit reel
 Use MMSD914T3 to order the 13 inch/10,000 unit reel

MMSD914T1

Motorola Preferred Device



1 0 2 CATHODE ANODE

CASE 425-04, STYLE 1 SOD-123

MAXIMUM RATINGS

and Charam Hum sale no Hum mu Rating to lostnop orex	Symbol	Value	Unit
Continuous Reverse Voltage	VR	100	Vdc
Peak Forward Current	feeding at a Feeding 1 281	200	mAdc
Peak Forward Surge Current	IFM(surge)	500	mA

DEVICE MARKING

MMSD914T1 = 5D

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board (1)	e estimate PD serio	225	mW
T _A = 25°C			
Derate above 25°C	transperse 34 057 rd	1.8	mW/°C
Thermal Resistance Junction to Ambient	R ₀ JA	556	°C/W
Total Device Dissipation Alumina Substrate (2) T₄ = 25°C	PD	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	ReJA	417	°C/W
Junction and Storage Temperature	T _J , T _{stg}	-55 to +150	°C

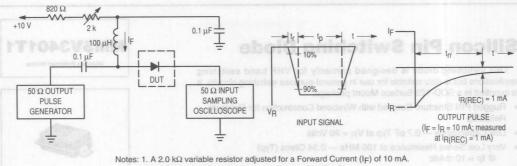
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{BR} = 100 \mu A$)	V _(BR)	100	- 1	V
Reverse Voltage Leakage Current ($V_R = 20 \text{ V}$) ($V_R = 75 \text{ V}$)	IR	=	25 5.0	nA μA
Forward Voltage (I _F = 10 mA)	VF		1000	mV
Diode Capacitance (V _R = 0 V, f = 1.0 MHz)	CD		4.0	pF
Reverse Recovery Time (I _F = I _R = 10 mA) (Figure 1)	t _{rr}	-	4.0	ns

(1) FR-5 = 1.0 x 0.75 x 0.062 in.

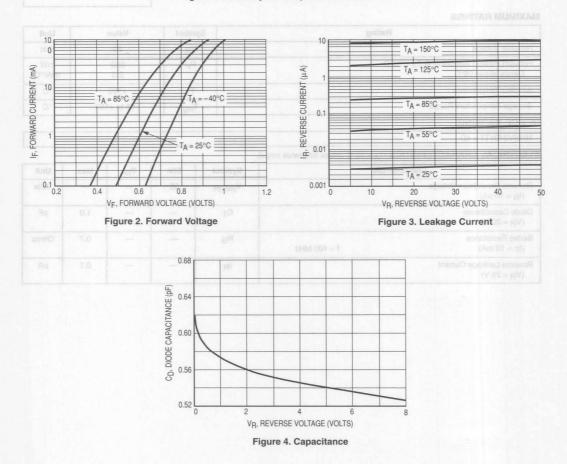
(2) Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Preferred devices are Motorola recommended choices for future use and best overall value.



- 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
- 3. tp » trr

Figure 1. Recovery Time Equivalent Test Circuit



Silicon Pin Switching Diode

This switching diode is designed primarily for VHF band switching applications but is also suitable for use in general-purpose switching circuits. It is supplied in a SOD-123 Surface Mount package.

- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Capacitance 0.7 pF Typ at V_B = 20 Volts
- Very Low Series Resistance at 100 MHz 0.34 Ohms (Typ)
 @ I_F = 10 mAdc
- Available in 8 mm Tape and Reel
 Use MMSV3401T1 to order the 7 inch/3,000 unit reel
 Use MMSV3401T3 to order the 13 inch/10,000 unit reel



MMSV3401T1

Motorola Preferred Device



CASE 425-04, STYLE 1 SOD-123

MAXIMUM RATINGS

Rating	Symbol	Value	Unit	
Reverse Voltage	VR	20	Vdc	
Forward Power Dissipation @ T _A = 25°C Derate above 25°C	PF	200 2.0	mW mW/°C	
Junction Temperature	TJ	+125	°C	
Storage Temperature Range	T _{stg}	-55 to +150	°C	

DEVICE MARKING

MMSV3401T1 = 4D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 μA)	V _{(BR)R}	35	90 120 120 120 120 120 120 120 120 120 12	A.D.	Volts
Diode Capacitance (V _R = 20 V)	СТ	loV brews	igure 2. Fi	1.0	pF
Series Resistance (IF = 10 mA) f = 100 MHz	RS	-	Ē	0.7	Ohms
Reverse Leakage Current (V _R = 25 V)	IR	80.0	-	0.1	μА

Preferred devices are Motorola recommended choices for future use and best overall value.

TYPICAL ELECTRICAL CHARACTERISTICS

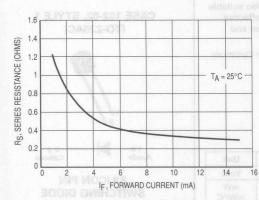


Figure 1. Series Resistance

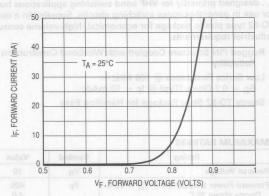


Figure 2. Forward Voltage

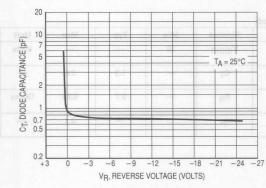


Figure 3. Diode Capacitance

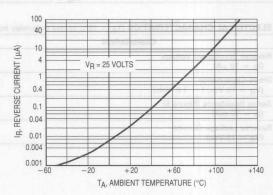
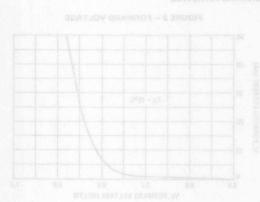
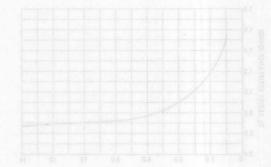


Figure 4. Leakage Current





SILICON PIN DIODE

... designed primarily for VHF band switching applications but also suitable for use in general-purpose switching circuits. Supplied in a cost effective TO-92 type plastic package for economical, high-volume consumer and industrial requirements.

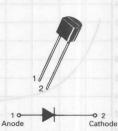
- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Series Resistance @ 100 MHz —
 RS = 0.7 Ohms (Typ) @ IF = 10 mAdc
- Sturdy TO-92 Style Package for Handling Ease

MAXIMUM RATINGS

Rating	Symbol	Value	Unit	
Reverse Voltage	V _R	20	Volts	
Forward Power Dissipation @ T _A = 25°C Derate above 25°C	PF	400 4.0	mW mW/°C	
Junction Temperature	TJ	+ 125	°C	
Storage Temperature Range	T _{stq}	-55 to +150	°C	

MPN3404*

CASE 182-02, STYLE 1 (TO-226AC)



SILICON PIN SWITCHING DIODE

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 µA)	V _{(BR)R}	20			Volts
Diode Capacitance (V _R = 15 Vdc, f = 1.0 MHz)	CT		1.3	2.0	pF
Series Resistance (Figure 5) (I _F = 10 mA)	RS	T	0.7	0.85	Ohms
Reverse Leakage Current (V _R = 15 Vdc)	IR			0.1	μΑ

TYPICAL ELECTRICAL CHARACTERISTICS

FIGURE 1 - SERIES RESISTANCE

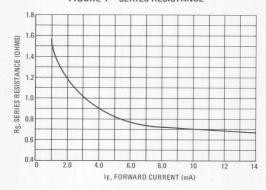


FIGURE 2 - FORWARD VOLTAGE

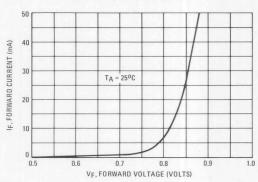


FIGURE 3 - DIODE CAPACITANCE

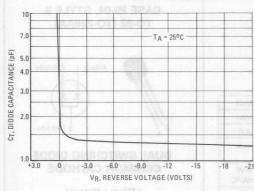


FIGURE 4 - LEAKAGE CURRENT

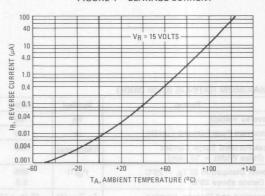
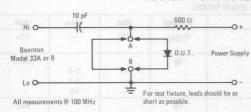


FIGURE 5 - FORWARD SERIES RESISTANCE TEST METHOD



To measure series resistance, a 10 pF capacitor is used to reduce the forward capacitance of the circuit and to prevent shorting of the external power supply through the bridge. The small signal from the bridge is prevented from shorting through the power supply by the 500-ohm resistor. The resistance of the 10 pF capacitor can be considered negligible for this measurement.

 The RF Admittance Bridge (Boonton 33A or B) must be initially balanced, with the test circuit connected to the bridge test terminals. The conductance scale will be set at zero and the capacitance scale will be set at 120 pF, as required when using the 100 MHz test coil.

- Use a short length of wire to short the test circuit from point "A" to "B". Then connect the power supply providing 10 mA of bias current to the test circuit.
- Adjust the capacitance scale arm of the bridge and the "G" zero control for a minimum null on the "null meter". The null occurs at approximately 130 pF.
- Replace the wire short with the device to be tested. Bias the device to a forward conductance state of 10 mA.
- Obtain a minimum null on the "null meter", with the capacitance and conductance scale adjustment arms.
- 6. Read conductance (G) direct from the scale. Now read the capacitance value from the scale $(\approx 130~\text{pF})$ and subtract 120~pF which yields capacitance (C). The forward resistance (RS) can now be calculated from:

$$R_S = \frac{2.533 \, G}{c^2}$$

Where:

G - in micromhos,

C - in pF,

MSD6100*

CASE 29-04, STYLE 3 TO-92 (TO-226AA)





DUAL SWITCHING DIODE COMMON CATHODE

★This is a Motorola designated preferred device.

MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	VR	100	Vdc
Recurrent Peak Forward Current	1F	200	mA
Peak Forward Surge Current (Pulse Width = 10 μsec)	IFM(surge)	500	mA
Power Dissipation @ T _A = 25°C Derate above 25°C	P _D (1)	625 5.0	mW mW/°C
Operating and Storage Junction Temperature Range	T _J , T _{stg} (1)	-55 to +135	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.) (EACH DIODE)

Characteristic	Symbol	Min	Max	Unit	
Breakdown Voltage (I _(BR) = 100 μAdc)		V _(BR)	100		Vdc
Reverse Current (V _R = 100 Vdc)		IR	* <u>0</u>	5.0	μAdc
(V _R = 50 Vdc)	- 0			0.1 50	
(V _R = 50 Vdc, T _A = 125°C)	no an an annual	Particular de la company de la		50	alest new 200
Forward Voltage (IF = 1.0 mAdc) (IF = 10 mAdc) (IF = 100 mAdc)	apober of P	VF	0.55 0.67 0.75	0.7 0.82 1.1	Vdc
Capacitance (V _R = 0)	the power the 16 pF	To governison o	e pro ul bern resissor. Th	1.5	pFi
Reverse Recovery Time (I _F = I _R = 10 mAdc, V _R = 5.0 Vdc, i _{rr} = 1.0 mAdc)	B) inust be	t _{rr}	or Bruge 18	4.0	ns

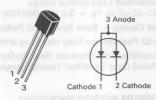
⁽¹⁾ Continuous package improvements have enhanced these guaranteed Maximum Ratings as follows: $P_D = 1.0 \text{ W} \ @ T_C = 25^{\circ}\text{C}$, Derate above $25^{\circ}\text{C} - 8.0 \text{ mW/}^{\circ}\text{C}$, $T_J = -65 \text{ to } +150^{\circ}\text{C}$, $\theta_{JC} = 125^{\circ}\text{C/W}$.

Pin 1 Pin 2

Rating	Symbol	Value	Unit
Reverse Voltage	VR	70	Vdc
Peak Forward Recurrent Current	IF	200	mA
Peak Forward Surge Current (Pulse Width = 10 μ s)	I _{FM(surge)}	500	mA
Total Device Dissipation @ T _A = 25°C Derate above 25°C	P _D (1)	625 5.0	mW mW°C
Operating and Storage Junction Temperature Range	T _J , T _{stg} (1)	-55 to +135	°C

MSD6150*

CASE 29-04, STYLE 4 TO-92 (TO-226AA)



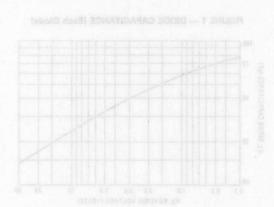
DUAL DIODE COMMON ANODE

★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.) (EACH DIODE)

Characteristic				I financia malauna	Symbol	Min	Тур	Max	Unit
Breakdown Voltage (I(BR) = 100 μAdc)	Typ	nibit	Symbol		V _(BR)	70	uto	-	Vdc
Reverse Current (V _R = 50 Vdc)					IR	-	<u>80</u> 4110	0.1	μAdc
Forward Voltage (I _F = 10 mAdc)			ni.		VF	TOX = AT	0.80	1.0	Vdc
Capacitance (V _R = 0)	URS		341		С	TURK CROA	5.0	8.0	pF
Reverse Recovery Time (I _F = I _R = 10 mAdc,)		dc, i _{rr} = 1.0	mAdc)	apacituose s = 1 0 Akte	t _{rr}	-	-	100	ns

(1) Continuous package improvements have enhanced these guaranteed Maximum Ratings as follows: $P_D = 1.0 \text{ W}$ @ $T_C = 25^{\circ}\text{C}$, Derate above 8.0 mW/°C, $P_D = 10 \text{ W}$ @ $T_C = 25^{\circ}\text{C}$, Derate above 80 mW/°C, T_J , $T_{stg} = -55 \text{ to} + 150^{\circ}$, $\theta_{JC} = 12.5^{\circ}\text{C/W}$, $\theta_{JA} = 125^{\circ}\text{C}$.



SILICON FPICAP DIODE

... designed for FM tuning, general frequency control and tuning, or any top-of-the-line application requiring back-to-back diode configurations for minimum signal distortion and detuning. This device is supplied in the popular TO-92 plastic package for high volume, economical requirements of consumer and industrial applications.

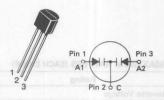
- High Figure of Merit —
 Q = 140 (Typ) @ V_R = 3.0 Vdc, f = 100 MHz
- Guaranteed Capacitance Range 37–42 pF @ V_B = 3.0 Vdc (MV104)
- Dual Diodes Save Space and Reduce Cost
- TO-92 Package for Easy Handling and Mounting
- Monolithic Chip Provides Near Perfect Matching Guaranteed ±1% (Max) Over Specified Tuning Range

MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	VR	32	Volts
Forward Current	l _F	200	mA
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PF	280 2.8	mW mW/°C
Junction Temperature	TJ	+ 125	°C
Storage Temperature Range	T _{stq}	-55 to +150	°C

MV104*

CASE 29-04, STYLE 15 (TO-226AA)



DUAL VOLTAGE-VARIABLE CAPACITANCE DIODE

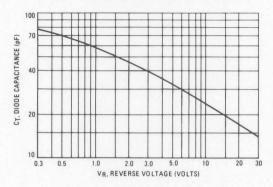
★This is a Motorola designated preferred device.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) (EACH DIODE)

Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 μAdc)	V _{(BR)R}	32	-	Them	Vdc
Reverse Voltage Leakage Current T _A = 25°C (V _R = 30 Vdc) T _A = 60°C	IR	I	Ξ	50 500	nAdc
Diode Capacitance Temperature Coefficient (V _R = 4.0 Vdc, f = 1.0 MHz)	TCC	-	280		ppm/°C

PD = 1.0 W @ TC = 25°C, Derete	V _R = 3.0 Vdd	C _T , Diode Capacitance V _R = 3.0 Vdc, f = 1.0 MHz pF		Q, Figure of Merit VR = 3.0 Vdc f = 100 MHz		C _R , Capacitance Ratio C ₃ /C ₃₀ f = 1.0 MHz	
Device	Min	Max	Min	Тур	Min	Max	
MV104	37	42	100	140	2.5	2.8	

FIGURE 1 — DIODE CAPACITANCE (Each Diode)



TYPICAL CHARACTERISTICS (Each Diode)

FIGURE 2 - FIGURE OF MERIT versus VOLTAGE

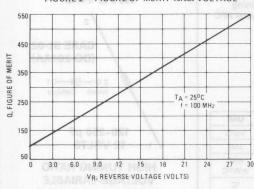


FIGURE 3 - FIGURE OF MERIT versus FREQUENCY

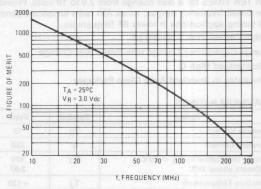


FIGURE 4 - DIODE CAPACITANCE versus TEMPERATURE

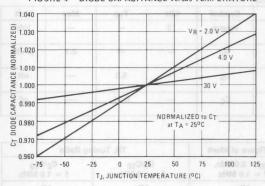
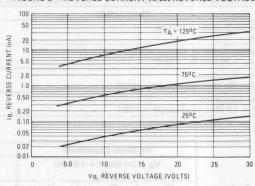


FIGURE 5 - REVERSE CURRENT versus REVERSE VOLTAGE



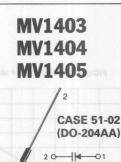
SILICON HYPER-ABRUPT TUNING DIODES

... designed with high capacitance and a capacitance change of greater than TEN TIMES for a bias change from 2.0 to 10 volts. Provides tuning over broad frequency ranges; tunes AM radio broadcast band, general AFC and tuning applications in lower RF frequencies.

- High Capacitance: 120-250 pF
- Large Capacitance Change with Small Bias Change
- Guaranteed High Q
- Available in Standard Axial Glass Packages

MAXIMUM RATINGS

Rating	Symbol	Value	Volts mA mW mW/°C	
Reverse Voltage	VR	12		
Forward Current	lF	250		
Device Dissipation @ T _A = 25°C Derate above 25°C	PD	400 2.67		
Junction Temperature	TJ	+ 125	°C	
Storage Temperature Range	T _{stg}	-65 to +200	°C	



Anode Cathode

120-250 pF 12 VOLTS

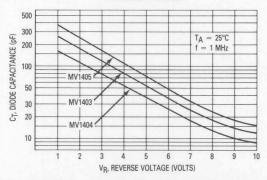
HIGH TUNING RATIO VOLTAGE-VARIABLE CAPACITANCE DIODES

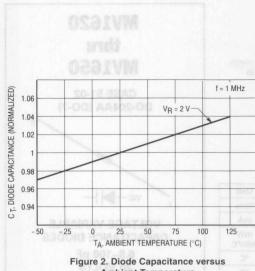
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Тур	Max —	Vdc
Reverse Breakdown Voltage (I _R = 10 μAdc)	V _{(BR)R}	12			
Leakage Current at Reverse Voltage (V _R = 10 Vdc, T _A = 25°C)	IR	7		0.1	μAdc
Series Inductance (f = 250 MHz, Lead Length \approx 1/16")	LS	-2	5.0	_	nH
Case Capacitance (f = 1.0 MHz, Lead Length \approx 1/16")	СС	-	0.25	-	pF

	C _T ,	C _T , Diode Capacitance		Q, Figure of Merit	TR, Tuning Ratio		
S VR		V _R = 2.0 Vdc, f = 1.0 MHz		V _R = 2.0 Vdc, f = 1.0 MHz	C ₁ /C ₁₀ f = 1.0 MHz	C ₂ /C ₁₀ f = 1.0 MHz	
Device	Min	Nom	Max	Min	Min	Min	
MV1403	140	175	210	200		10	
MV1404	96	120	144	200		10	
MV1405	200	250	300	200		10	

FIGURE 1 — DIODE CAPACITANCE versus REVERSE VOLTAGE







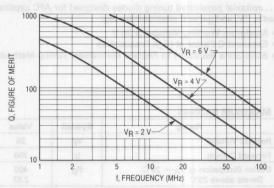


Figure 3. Figure of Merit versus Frequency

SILICON EPICAP DIODES

... epitaxial passivated tuning diodes designed for AFC applications in radio, TV, and general electronic-tuning.

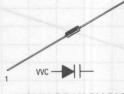
- Maximum Working Voltage of 20 V
- Excellent Q Factor at High Frequencies
- Solid-State Reliability to Replace Mechanical Tuning Methods

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	VR	20	Volts
Forward Current	IF	250	mA
Device Dissipation @ T _A = 25°C Derate above 25°C	PD	400 2.67	mW mW/°C
Junction Temperature	July C. Tjury	+ 175	°C
Storage Temperature Range	T _{stq}	-65 to +200	°C

MV1620 thru MV1650

CASE 51-02 DO-204AA (DO-7)



VOLTAGE-VARIABLE CAPACITANCE DIODES

6.8-100 pF 20 VOLTS

ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

Characteristic	Symbol	Min	Тур	Max	Unit
Reverse Breakdown Voltage , (IR = 10 μ Adc)	BVR	20		-	Vdc
Reverse Voltage Leakage Current (V _R = 15 Vdc, T _A = 25°C)	IR	176	-	0.10	μAdc
Series Inductance (f = 250 MHz, Lead Length \approx 1/16")	LS		4.0	_	nH
Case Capacitance (f = 1.0 MHz, Lead Length \approx 1/16")	CC	-	0.17	-	pF

		C _t , Diode Capacitance V _R = 4.0 Vdc, f = 1.0 MHz pF		Q, Figure of Merit VR = 4.0 Vdc f = 50 MHz	T _R , Tuning Ratio C ₂ /C ₂₀ f = 1.0 MHz	
Device	Min	Nom	Max	Тур	Min	Max
MV1620	6.1	6.8	7.5	300	2.0	3.2
MV1624	9.0	10.0	11.0	300	2.0	3.2
MV1626	10.8	12.0	13.2	300	2.0	3.2
MV1628	13.5	15.0	16.5	250	2.0	3.2
MV1630	16.2	18.0	19.8	250	2.0	3.2
MV1634	19.8	22.0	24.2	250	2.0	3.2
MV1636	24.3	27.0	29.7	200	2.0	3.2
MV1638	29.7	33.0	36.3	200	2.0	3.2
MV1640	35.1	39.0	42.9	200	2.0	3.2
MV1642	42.3	47.0	51.7	200	2.0	3.2
MV1644	50.4	56.0	61.6	150	2.0	3.2
MV1648	73.8	82.0	90.2	150	2.0	3.2
MV1650	90.0	100.0	110.0	150	2.0	3.2

TR, Tuning Ratio, is the ratio of C_T measured at 2 Vdc divided by C_T measured at 20 Vdc.

MV7005T1

Motorola Preferred Device

SOT-223 PACKAGE HIGH CAPACITANCE VOLTAGE-VARIABLE DIODE

SURFACE MOUNT



Silicon Epicap Diode

This silicon epicap diode is designed for use in high capacitance, high-tuning ratio applications. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- Guaranteed Capacitance Range
- SOT-223 Package can be Soldered Using Wave or Reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 12 mm Tape and Reel Use MV7005T1 to order the 7 inch/1000 unit reel. Use MV7005T3 to order the 13 inch/4000 unit reel.



MAXIMUM RATINGS

Rating	Symbol	Value	Unit	
Reverse Voltage	V _R	15	Volts	
Forward Current	IF	50	mA	
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PD sHMQ.I=1	280 2.8	mW mW/°C	
Junction Temperature	TJ	+125	°C	
Storage Temperature Range	T _{stg}	-55 to +125	°C	

DEVICE MARKING

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Reverse Breakdown Voltage (I _R = 10 μAdc)	V _{(BR)R}	15	= =	Vdc
Reverse Voltage Leakage Current (V _R = 9.0 Vdc)	IR	-	100	nAdc
Diode Capacitance (V _R = 1.0 Vdc, f = 1.0 MHz)	СТ	400	520	pF
Capacitance Ratio C1/C9 (f = 1.0 MHz)	CR	12		-
Figure of Merit (V _B = 1.0 Vdc, f = 1.0 MHz)	Q	150	-	-

Preferred devices are Motorola recommended choices for future use and best overall value.

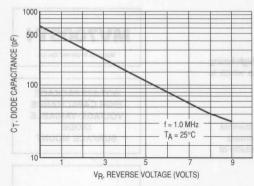


Figure 1. Diode Capacitance versus Reverse Voltage

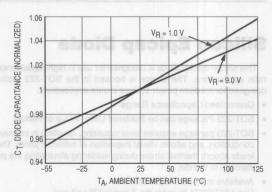
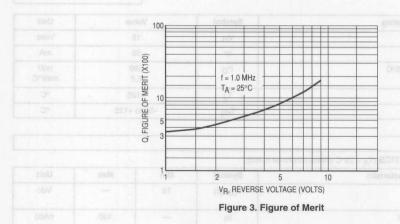


Figure 2. Diode Capacitance versus

Ambient Temperature



Silicon Hyper-Abrupt Tuning Diode

This silicon tuning diode is designed for high capacitance and a tuning ratio of greater than 10 times over a bias range of 2.0 to 10 volts. It provides tuning over a broad frequency range from the AM broadcast band to 100 MHz. The device is housed in the SOT-223 package, which is designed for medium power surface mount applications.

- High Capacitance
- Large Capacitance Change with Small Bias Change
- · Guaranteed High Q
- The SOT-223 Package can be soldered using Wave or Reflow
- SOT-223 package ensures level mounting which results in improved thermal conduction and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die.
- Available in 12 mm Tape and Reel
 Use MV7404T1 to order the 7 inch/1000 unit reel
 Use MV7404T3 to order the 13 inch/4000 unit reel



MV7404T1

Motorola Preferred Device

SOT-223 PACKAGE HIGH TUNING RATIO VOLTAGE-VARIABLE SURFACE MOUNT DIODE



MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit	
Reverse Voltage	VR	12	Volts	
Forward Current	IF I	250	mA	
Total Power Dissipation @ T _A = 25°C Derate above 25°C	PD	280 2.8	mW mW/°C	
Operating and Storage Temperature Range	TJ, T _{stg}	-55 to 125	°C	
Lead Temperature for Soldering Purposes, 1/6" from case Time in Solder Bath	TL	260 10	°C Sec	

DEVICE MARKING

V7404

ELECTRICAL CHARACTERISTICS (TA = 25°C)

Characteristic RHM YOMSUUSHA A			Min	Тур	Max	Unit
Reverse Breakdown Voltage (I _R = 10 μAdc)	Figure of Marit versus Frequency	V _{(BR)R}	12		-	Vdc
Reverse Voltage Leakage Current (V _R = 10 Vdc, f = 1.0 MHz)		IR	-		100	nAdc
Diode Capacitance (V _R = 2.0 Vdc, f = 1.0 MHz)		CT	96	120	144	pF
Figure of Merit (V _R = 2.0 Vdc, f = 1.0 MHz)		Q	200	-	-	-
Tuning Ratio C2/C10 (f = 1.0 MHz)		TR	10	-	-	-

^{*} Device mounted on minimum recommended footprint.

Preferred devices are Motorola recommended choices for future use and best overall value.

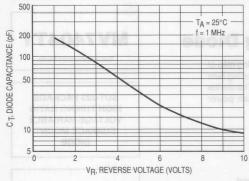


Figure 1. Diode Capacitance versus Reverse Voltage

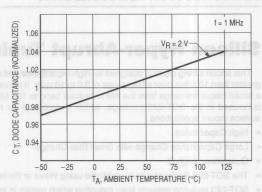


Figure 2. Diode Capacitance versus

Ambient Temperature

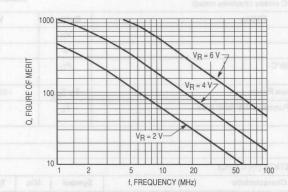


Figure 3. Figure of Merit versus Frequency

SILICON TUNING DIODES

... designed for electronic tuning of AM receivers and high capacitance, high tuning ratio applications.

- High Capacitance Ratio C_R = 15 (Min), MVAM108, 115, 125
- Guaranteed Diode Capacitance $C_t=440~pF$ (Min) 560 pF (Max) @ $V_R=1.0~VDc,~f=1.0~MHz,~MVAM108,~MVAM115,~MVAM125$
- Guaranteed Figure of Merit —
 Q = 150 (Min) @ V_R = 1.0 Vdc, f = 1.0 MHz

MAXIMUM RATINGS

MAXIMOM HATIMOS				
Rating		Symbol	Value	Unit
Reverse Voltage	MVAM108 MVAM109 MVAM115 MVAM125	VR	12 15 18 28	Volts
Forward Current	1) IF	50	mA
Power Dissipation @ T _A = 25°C Derate above 25°C		PD	280 2.8	mW mW/°C
Operating and Storage Junction Temperature Range		T _J , T _{stg}	-55 to +125	°C

MVAM108*
MVAM109*
MVAM115*
MVAM125*

CASE 182-02, STYLE 1 (TO-226AC)



Cathode

TUNING DIODES
WITH VERY HIGH
CAPACITANCE RATIO

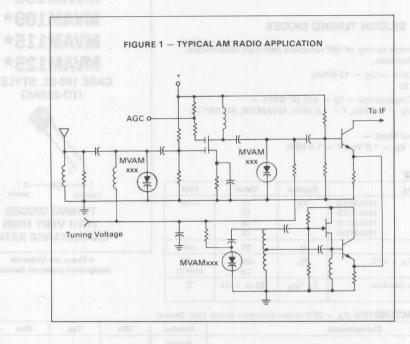
★These are Motorola designated preferred devices.

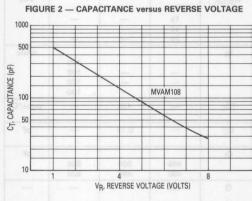
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted, Each Device)

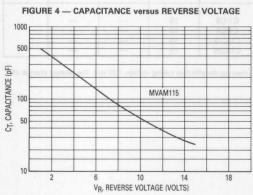
Characteris	tic	Symbol	Min	Тур	Max	Unit
Breakdown Voltage (IR = 10 μ Adc) MVAM108 MVAM109 MVAM115 MVAM125		V(BR)R	12 15 18 28	nov 3—KATE	109A - S	Vdc
Reverse Current (V _R = 8.0 V) (V _R = 9.0 V) (V _R = 15 V) (V _R = 25 V)	MVAM108 MVAM109 MVAM115 MVAM125	IR	SEL MANTE		100 100 100 100	nAdc
Diode Capacitance Temperatujre Coefficient (1) (V _R = 1.0 Vdc, f = 1.0 MHz, T _A = -40°C to +85°C)		TCC		435		ppm/°C
Case Capacitance (f = 1.0 MHz, Lead Length 1/16")	3	CC	4-1	0.18	+	pF
Diode Capacitance (V _R = 1.0 Vdc, f = 1.0 MHz)	MVAM108, 115, 125 MVAM109	Ct	440 400	500 460	560 520	pF
Figure of Merit (f = 1.0 MHz, Lead Length 1/16", V _R =		Q	150	DOV BENTER VOL	_	-
Capacitance Ratio (f = 1.0 MHz)	MVAM108 MVAM109 MVAM115 MVAM125	C1/C8 C1/C9 C1/C15 C1/C25	15 12 15 15	STANCE Vers	4 CAPAI	POOL SOOR

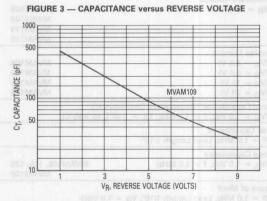
NOTES:

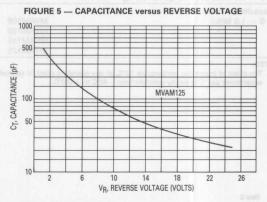
The effect of increasing temperature 1.0°C, at any operating point, is equivalent to lowering the effective tuning voltage 1.25 mV. The percent change of capacitance per °C is nearly constant from -40°C to +100°C.











skaging Specifications

Section 6

Tape and Reel Specifications, Packaging Specifications and Leadform Options



EMBOSSED TAPE AND REEL ORDERING INFORMATION

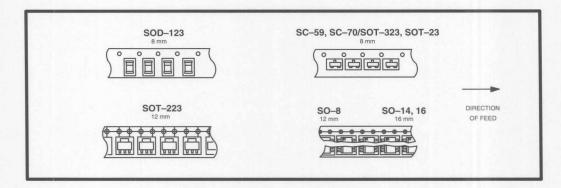
Tape and Reel Specifications and Packaging Specifications

Embossed Tape and Reel is used to facilitate automatic pick and place equipment feed requirements. The tape is used as the shipping container for various products and requires a minimum of handling. The antistatic/conductive tape provides a secure cavity for the product when sealed with the "peel-back" cover tape.

- Two Reel Sizes Available (7" and 13")
- Used for Automatic Pick and Place Feed Systems
- Minimizes Product Handling
- EIA 481, -1, -2

- SOD-123, SC-59, SC-70/SOT-323, SOT-23 in
- 8 mm Tape
- SO-8, SOT-223 in 12 mm Tape
- SO-14, SO-16 in 16 mm Tape

Use the standard device title and add the required suffix as listed in the option table on the following page. Note that the individual reels have a finite number of devices depending on the type of product contained in the tape. Also note the minimum lot size is one full reel for each line item, and orders are required to be in increments of the single reel quantity.

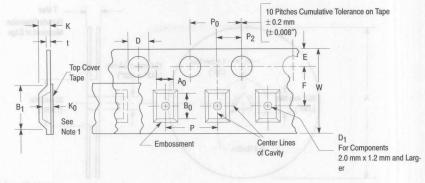


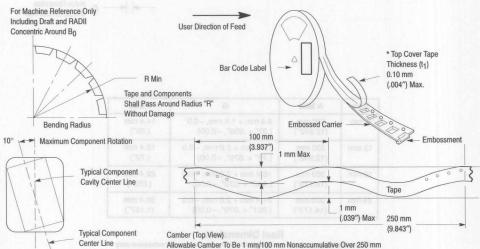
EMBOSSED TAPE AND REEL ORDERING INFORMATION

Package	Tape Width (mm)	Pitch mm (inch)	Reel Size mm (inch)	Devices Per Reel and Minimum Order Quantity	Device Suffix
SC-59	8	4.0 ± 0.1 (.157 ± .004)	178 (7)	3,000	T1
SC-70/SOT-323	8 8	4.0 ± 0.1 (.157 ± .004)	178 (7) 330 (13)	3,000 10,000	T1 T3
SO-8	12 12	8.0 ± 0.1 (.315 ± .004)	178 (7) 330 (13)	500 2,500	R1 R2
SO-14	16 16	8.0 ± 0.1 (.315 ± .004)	178 (7) 330 (13)	500 2,500	R1 R2
SO-16	16 16	8.0 ± 0.1 (.315 ± .004)	178 (7) 330 (13)	500 2,500	R1 R2
SOD-123	8 8	4.0 ± 0.1 (.157 ± .004)	178 (7) 330 (13)	3,000 10,000	T1 T3
SOT-23	8 8 8	4.0 ± 0.1 (.157 ± .004)	178 (7) 330 (13) 330 (13)	3,000 10,000 10,000	T1 T3 T3
SOT-223	12 12	8.0 ± 0.1 (.315 ± .004)	178 (7) 330 (13)	1,000 4,000	T1 T3

EMBOSSED TAPE AND REEL DATA FOR DISCRETES

CARRIER TAPE SPECIFICATIONS





DIMENSIONS

Tape Size	B ₁ Max	D	D ₁	E	F	к	P ₀	P ₂	R Min	T Max	W Max
8 mm	4.55 mm (.179")	1.5+0.1 mm -0.0	04" (.039")	(.069±.004")	3.5±0.05 mm (.138±.002")	2.4 mm Max (.094")	4.0±0.1 mm (.157±.004")		25 mm (.98")		8.3 mm (.327")
12 mm	8.2 mm (.323")	(.059 + .004" - 0.0)			5.5±0.05 mm (.217±.002")	6.4 mm Max (.252")					12±.30 mm (.470±.012")
16 mm	12.1 mm (.476")				7.5±0.10 mm (.295±.004")	7.9 mm Max (.311")					16.3 mm (.642")
24 mm	20.1 mm (.791")				11.5±0.1 mm (.453±.004")	11.9 mm Max (.468")					24.3 mm (.957")

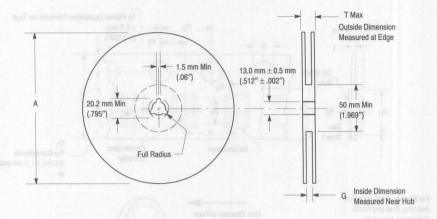
Metric dimensions govern — English are in parentheses for reference only.

NOTE 1: A₀, B₀, and K₀ are determined by component size. The clearance between the components and the cavity must be within .05 mm min. to .50 mm max., the component cannot rotate more than 10° within the determined cavity.

NOTE 2: If B₁ exceeds 4.2 mm (.165) for 8 mm embossed tape, the tape may not feed through all tape feeders.

NOTE 3: Pitch information is contained in the Embossed Tape and Reel Ordering Information on pg. 5.12–3.

EMBOSSED TAPE AND REEL DATA FOR DISCRETES



Size	A Max	G Tauther by	T Max	
8 mm	330 mm (12.992")	8.4 mm + 1.5 mm, -0.0 (.33" + .059", -0.00)	14.4 mm (.56")	
		12.4 mm + 2.0 mm, -0.0 (.49" + .079", -0.00)	18.4 mm (.72")	
		16.4 mm + 2.0 mm, -0.0 (.646" + .078", -0.00)	22.4 mm (.882")	
24 mm 360 mm (14.173")		24.4 mm + 2.0 mm, -0.0 (.961" + .070", -0.00)	30.4 mm (1.197")	

Reel Dimensions

Metric Dimensions Govern — English are in parentheses for reference only

TO-92 EIA, IEC, EIAJ Radial Tape in Fan Fold Box or on Reel

Radial tape in fan fold box or on reel of the reliable TO–92 package are the best methods of capturing devices for automatic insertion in printed circuit boards. These methods of taping are compatible with various equipment for active and passive component insertion.

- Available in Fan Fold Box
- · Available on 365 mm Reels
- Accommodates All Standard Inserters
- Allows Flexible Circuit Board Layout
- 2.5 mm Pin Spacing for Soldering
- EIA-468, IEC 286-2, EIAJ RC1008B

TO-92 RADIAL TAPE IN FAN FOLD BOX OR ON REEL



Ordering Notes:

When ordering radial tape in fan fold box or on reel, specify the style per Figures 3 through 8. Add the suffix "RLR" and "Style" to the device title, i.e. MPS3904RLRA. This will be a standard MPS3904 radial taped and supplied on a reel per Figure 9.

Fan Fold Box Information — Order in increments of 2000.

Reel Information — Order in increments of 2000.

US/European Suffix Conversions

US	EUROPE
RLRA	RL
00.0 RLRE	RL1
RLRM	ZL1 8890

TO-92 EIA RADIAL TAPE IN FAN FOLD BOX OR ON REEL

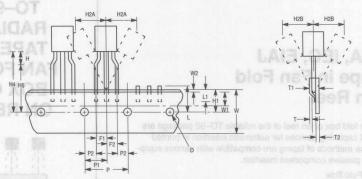


Figure 1. Device Positioning on Tape

		Juoya.	Specification				
Symbol		Inc	hes	Millimeter			
	Item	Min	Max	Min	Max		
D	Tape Feedhole Diameter	0.1496	0.1653	3.8	4.2		
D2	Component Lead Thickness Dimension	0.015	0.020	0.38	0.51		
F1, F2	Component Lead Pitch	0.0945	0.110	2.4	2.8		
Н	Bottom of Component to Seating Plane	.059	.156	1.5	4.0		
H1	Feedhole Location	0.3346	0.3741	8.5	9.5		
H2A	Deflection Left or Right	0	0.039	0	1.0		
H2B	Deflection Front or Rear .000\$ to also	metonio net	0.051	0 xe	1.0		
H4	Feedhole to Bottom of Component	0.7086	0.768	18	19.5		
H5	Feedhole to Seating Plane	0.610	0.649	15.5	16.		
L	Defective Unit Clipped Dimension	0.3346	0.433	8.5	- 11		
L1	Lead Wire Enclosure enclarevno@xilhu2 neagous120	0.09842	_	2.5	_		
Р	Feedhole Pitch	0.4921	0.5079	12.5	12.9		
P1	Feedhole Center to Center Lead	0.2342	0.2658	5.95	6.7		
P2	First Lead Spacing Dimension	0.1397	0.1556	3.55	3.9		
Т	Adhesive Tape Thickness	0.06	0.08	0.15	0.20		
T1	Overall Taped Package Thickness	18	0.0567	_	1.4		
T2	Carrier Strip Thickness	0.014	0.027	0.35	0.6		
W	Carrier Strip Width	0.6889	0.7481	17.5	19		
W1	Adhesive Tape Width	0.2165	0.2841	5.5	6.3		
W2	Adhesive Tape Position	.0059	0.01968	.15	0.5		

- 1. Maximum alignment deviation between leads not to be greater than 0.2 mm.
- Defective components shall be clipped from the carrier tape such that the remaining protrusion (L) does not exceed a maximum of 11 mm.
 Component lead to tape adhesion must meet the pull test requirements established in Figures 5, 6 and 7.
- 4. Maximum non-cumulative variation between tape feed holes shall not exceed 1 mm in 20 pitches.

- 4. Maximum from customative variation between tape feet moles shall be no exposure of adhesive.

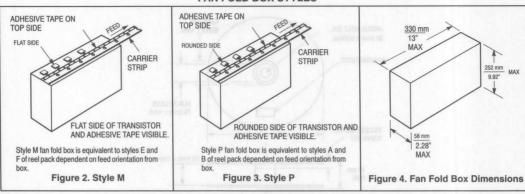
 5. Holddown tape not to extend beyond the edge(s) of carrier tape and there shall be no exposure of adhesive.

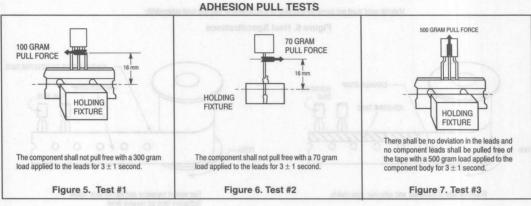
 6. No more than 1 consecutive missing component is permitted.

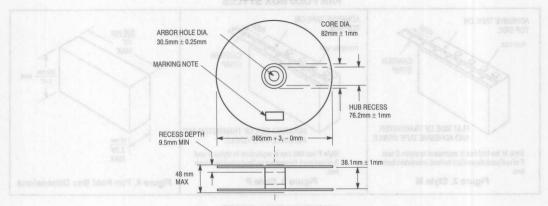
 7. A tape trailer and leader, having at least three feed holes is required before the first and after the last component.
- Splices will not interfere with the sprocket feed holes.

TO-92 EIA RADIAL TAPE IN FAN FOLD BOX OR ON REEL

FAN FOLD BOX STYLES







Material used must not cause deterioration of components or degrade lead solderability Figure 8. Reel Specifications ADHESIVE TAPE ON REVERSE SIDE CARRIER STRIP CARRIER STRIP ROUNDED FLAT SIDE SIDE ADHESIVE TAPE 0 010 0 0 FEED-FEED -Rounded side of transistor and adhesive tape visible. Flat side of transistor and carrier strip visible

Figure 9. Style A

CARRIER STRIP

ADHESIVE TAPE

FLAT SIDE

ADHESIVE TAPE ON REVERSE SIDE ROUNDED CARRIER STRIP 010 0 FEED

Figure 10. Style B

(adhesive tape on reverse side).

Flat side of transistor and adhesive tape visible.

Figure 11. Style E

Rounded side of transistor and carrier strip visible (adhesive tape on reverse side).

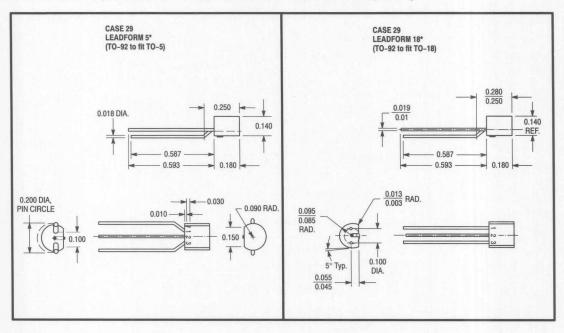
Figure 12. Style F

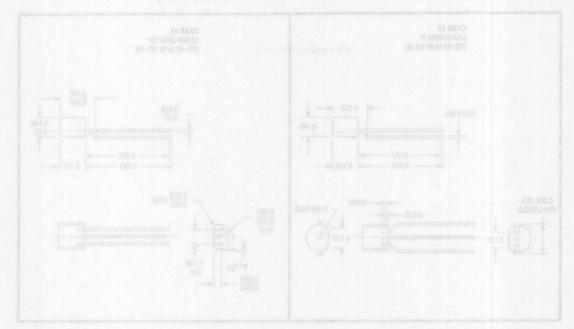
FEED.

Leadform Options — TO-92 (Case 29)

Plastic packaged semiconductors may be leadformed to a variety of configurations for insertion into sockets or circuit boards. Leadform options require assignment of a special part number before ordering. To order leadformed product, determine the desired leadform, the

case number and applicable leadform number, then contact your local Motorola representative for the special part number and pricing. Leadform orders require a minimum order quantity and are non-cancellable after processing.





Section 7

Surface Mount Information

In Brief . . .

Surface Mount Technology is now being utilized to offer answers to many problems that have been created in the use of insertion technology.

Limitations have been reached with insertion packages and PC board technology. Surface Mount Technology offers the opportunity to continue to advance the state-of-the-art designs that cannot be accomplished with Insertion Technology.

Surface Mount Packages allow more optimum device performance with the smaller Surface Mount configuration. Internal lead lengths, parasitic capacitance and inductance that placed limitations on chip performance have been reduced.

The lower profile of Surface Mount Packages allows more boards to be utilized in a given amount of space. They are stacked closer together and utilize less total volume than insertion populated PC boards.

Printed circuit costs are lowered with the reduction of the number of board layers required. The elimination or reduction of the number of plated through holes in the board contribute significantly to lower PC board prices.

Surface Mount assembly does not require the preparation of components that is common on insertion technology lines. Surface Mount components are sent directly to the assembly line, eliminating an intermediate step.

Automatic placement equipment is available that can place Surface Mount components at the rate of a few thousand per hour to hundreds of thousands of components per hour.

Surface Mount Technology is cost effective, allowing the manufacturer the opportunity to produce smaller units and offer increased functions with the same size product.

INFORMATION FOR USING SURFACE MOUNT PACKAGES

RECOMMENDED FOOTPRINTS FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to ensure proper solder connection interface

between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.

POWER DISSIPATION FOR A SURFACE MOUNT DEVICE

The power dissipation for a surface mount device is a function of the drain/collector pad size. These can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient, and the operating temperature, T_A . Using the values provided on the data sheet, P_D can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device. For example, for a SOT–223 device, P_D is calculated as follows.

$$P_D = \frac{150^{\circ}C - 25^{\circ}C}{156^{\circ}C/W} = 800 \text{ milliwatts}$$

The 156°C/W for the SOT–223 package assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 800 milliwatts. There are other alternatives to achieving higher power dissipation from the surface mount packages. One is to increase the area of the drain/collector pad. By increasing the area of the drain/collector pad, the power dissipation can be increased.

Although the power dissipation can almost be doubled with this method, area is taken up on the printed circuit board which can defeat the purpose of using surface mount technology. For example, a graph of $R_{\theta JA}$ versus drain pad area is shown in Figure 1.

Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad™. Using a board material such as Thermal Clad, an aluminum core board, the power dissipation can be doubled using the same footbrint.

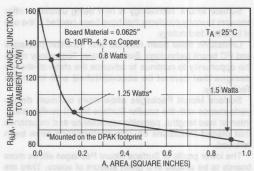


Figure 1. Thermal Resistance versus Drain Pad Area for the SOT–223 Package (Typical)

SOLDER STENCIL GUIDELINES

Prior to placing surface mount components onto a printed circuit board, solder paste must be applied to the pads. Solder stencils are used to screen the optimum amount. These stencils are typically 0.008 inches thick and may be made of

brass or stainless steel. For packages such as the SC–59, SC–70/SOT–323, SOD–123, SOT–23, SOT–223, SO–8, SO–14, and SO–16 packages, the stencil opening should be the same as the pad size or a 1:1 registration.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

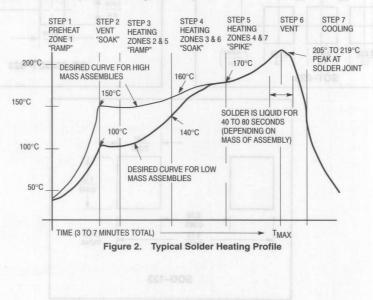
- · Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference should be a maximum of 10°C.

- The soldering temperature and time should not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient should be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used since the use of forced cooling will increase the temperature gradient and will result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling.
- * Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

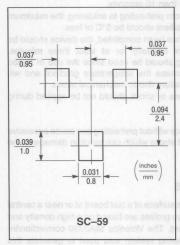
TYPICAL SOLDER HEATING PROFILE

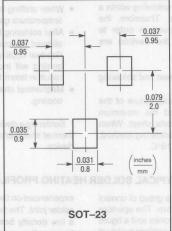
For any given circuit board, there will be a group of control settings that will give the desired heat pattern. The operator must set temperatures for several heating zones and a figure for belt speed. Taken together, these control settings make up a heating "profile" for that particular circuit board. On machines controlled by a computer, the computer remembers these profiles from one operating session to the next. Figure 2 shows a typical heating profile for use when soldering a surface mount device to a printed circuit board. This profile will vary among soldering systems, but it is a good starting point. Factors that can affect the profile include the type of soldering system in use, density and types of components on the board, type of solder used, and the type of board or substrate material being used. This profile shows temperature versus time. The line on the graph shows the actual temperature that might be

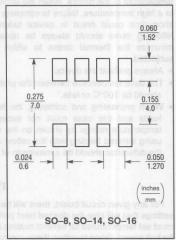
experienced on the surface of a test board at or near a central solder joint. The two profiles are based on a high density and a low density board. The Vitronics SMD310 convection/infrared reflow soldering system was used to generate this profile. The type of solder used was 62/36/2 Tin Lead Silver with a melting point between 177–189°C. When this type of furnace is used for solder reflow work, the circuit boards and solder joints tend to heat first. The components on the board are then heated by conduction. The circuit board, because it has a large surface area, absorbs the thermal energy more efficiently, then distributes this energy to the components. Because of this effect, the main body of a component may be up to 30 degrees cooler than the adjacent solder joints.

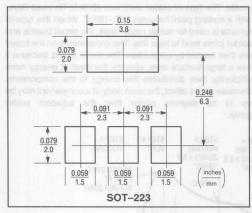


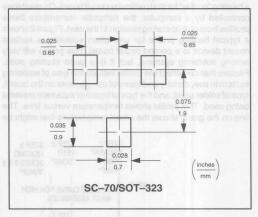
Footprints for Soldering

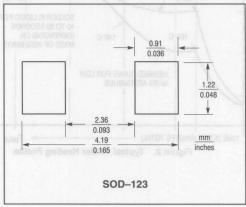












Section 8

Package Outline Dimensions and Applications Literature

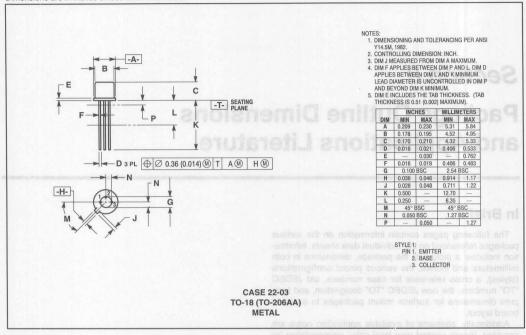
In Brief . . .

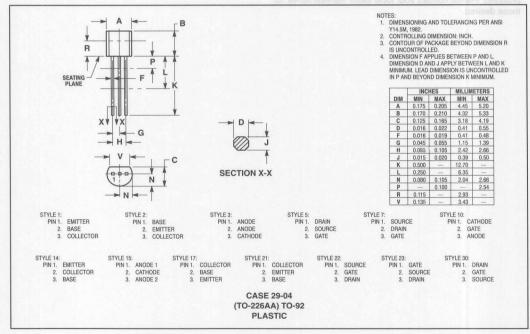
The following pages contain information on the various packages referenced on the individual data sheets. Information includes: a picture of the package, dimensions in both millimeters and inches, the various pinout configurations (styles), a cross reference for case numbers, old JEDEC "TO" numbers, the new JEDEC "TO" designation, and footprint dimensions for surface mount packages to assist in board layout.

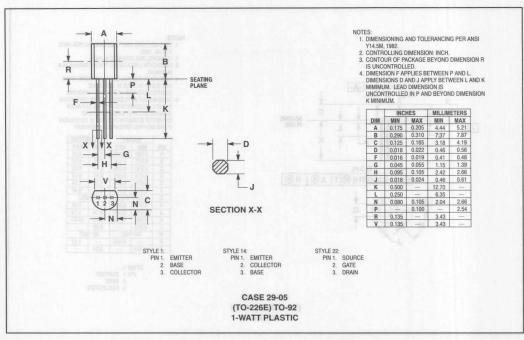
Additionally, abstracts of available application notes are provided. Please contact your local sales representative for those desired.

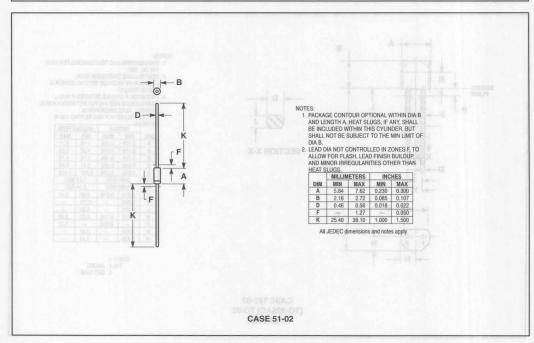
Package Outline Dimensions

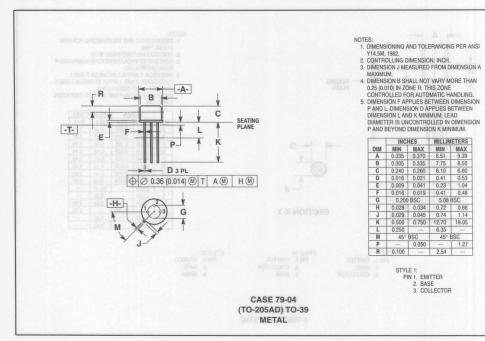
Dimensions are in inches unless otherwise noted.

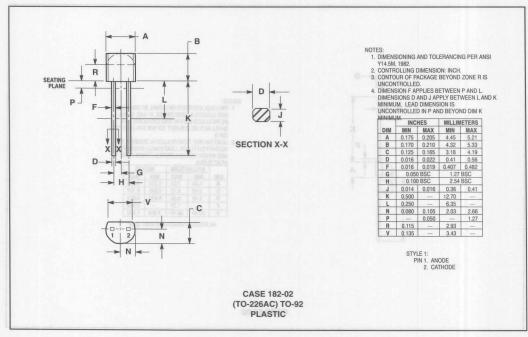


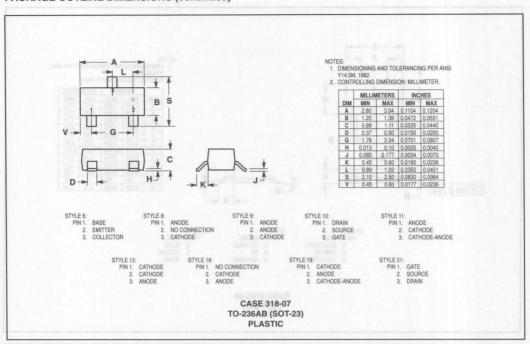


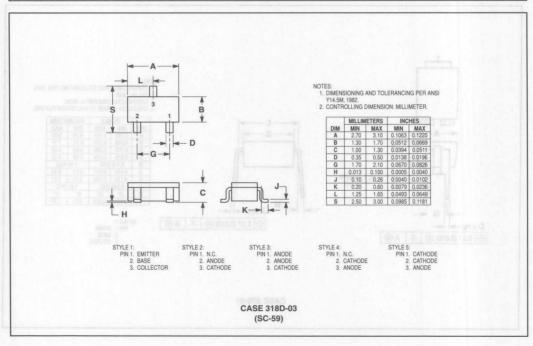


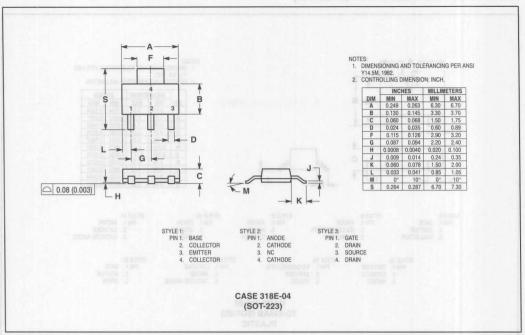


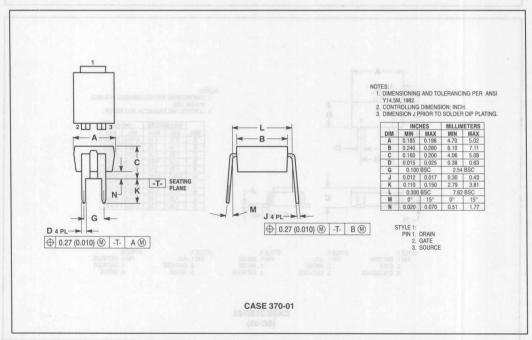


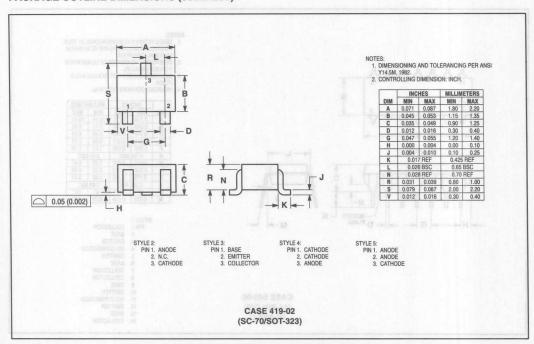


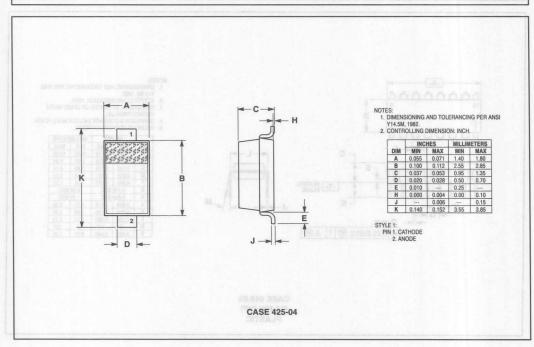


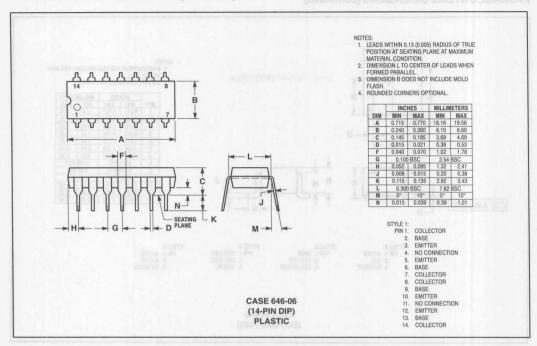


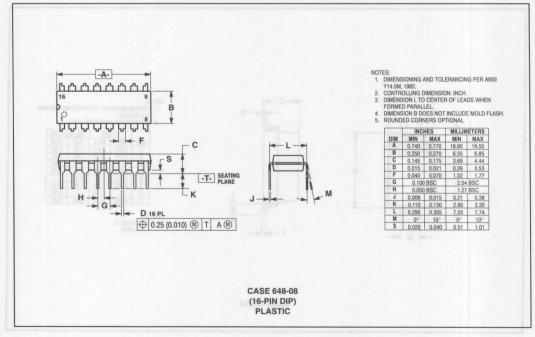


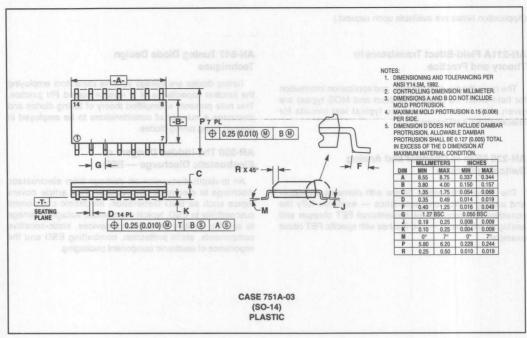


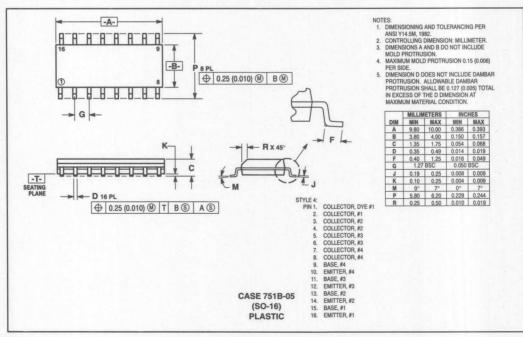












Application Note Abstracts

(Application Notes are available upon request.)

AN-211A Field-Effect Transistors in Theory and Practice

The basic theory, construction, and application information for field-effect transistors (junction and MOS types) are given. Also included are some typical test circuits for checking FET parameters.

AN-220 FETs in Chopper and Analog **Switching Circuits**

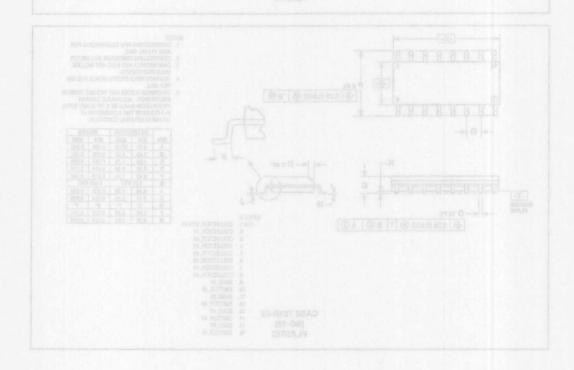
The author's discussion begins with elementary chopper and analog switch characteristics - explores fully the considerations required for conventional FET chopper and analog switch design — and finishes with specific FET circuit examples.

AN-847 Tuning Diode Design Techniques

Tuning diodes are voltage variable capacitors employing the junction capacitance of a reverse biased PN junction. This note presents a simplified theory of tuning diodes and discusses a number of considerations to be employed in designs using tuning diodes.

AR-300 The Hidden Dangers of Electrostatic Discharge — ESD

An in-depth discussion on damage from electrostatic discharge to electronic components. This article covers topics such as ESD Generation, electronic component susceptibility to ESD, typical electrostatic voltages, damage to specific families of electronic devices, static-sensitive components, static protection, combatting ESD and the importance of electronic component packaging.



Section 9

Reliability and Quality Assurance

In Brief . . .

This Reliability and Quality Assurance section contains information on the measurement of outgoing quality, reliability data analysis, reliability stress test descriptions with the applicable MIL-STD methods, statistical process control techniques, and quality assurance processing.

RELIABILITY DATA ANALYSIS

Reliability is the probability that a semiconductor device will perform its specified function in a given environment for a specified period. In other words, reliability is quality over time and environmental conditions. The most frequently used and environmental conditions. The most frequently used reliability measure for sentenced by dividing the number of fallures observed by the graduat of the number of fallures observed by the graduat of the number of fallures operated from a fallures per tillion devices from (FTS), per thousand from soft fallures per tillion devices from schedule point estimate because it is obtained from observations on a portion (sample) of the population of To project from the sample to the population in general, devices.

To project from the sample to the population in general, one must establish confidence intervals. The application of confidence intervals is a statement of how "confident" one is that the sample fellure, rate approximates that for the

rearvad and expected frequencies of an event is traquently at to establish confidence intervals. The relationship ween failure rate and five chi-square distribution is as owe;

OUTGOING QUALITY

The Average Outgoing Quality (AOQ) refers to the number of devices per million that are outside the specification limits at the time of shipment. Motorola has established Six Sigma goals to improve its outgoing quality and will continue its "error free performance" focus to achieve the goal of zero parts per million (PPM) outgoing quality. Motorola's present quality level has lead to vendor certification programs with many of its customers. These programs ensure a level of quality which allows the customer either to reduce or eliminate the need for incoming inspections.

AVERAGE OUTGOING QUALITY (AOQ) CALCULATION

AOQ = (Process Average) • (Probability of Acceptance) • (10⁶) (PPM)

- Process Average = Total Projected Reject Devices
 Total Number of Devices
- $\bullet \ \, \text{Projected Reject Devices} = \frac{\text{Defects in Sample}}{\text{Sample Size}} \bullet \text{Lot Size}$
- Total Number of Devices = Sum of units in each submitted lot
- Probability of Acceptance = 1 Number of Lots Rejected Number of Lots Tested
- 10⁶ = Conversion to parts per million (PPM)

RELIABILITY DATA ANALYSIS

Reliability is the probability that a semiconductor device will perform its specified function in a given environment for a specified period. In other words, reliability is quality over time and environmental conditions. The most frequently used reliability measure for semiconductor devices is the failure rate (λ). The failure rate is obtained by dividing the number of failures observed by the product of the number of devices on test and the interval in hours, usually expressed as percent per thousand hours or failures per billion device hours (FITS). This is called a point estimate because it is obtained from observations on a portion (sample) of the population of devices.

To project from the sample to the population in general, one must establish confidence intervals. The application of confidence intervals is a statement of how "confident" one is that the sample failure rate approximates that for the population. To obtain failure rates at different confidence levels, it is necessary to make use of specific probability distributions. The chi-square $(\chi 2)$ distribution that relates observed and expected frequencies of an event is frequently used to establish confidence intervals. The relationship between failure rate and the chi-square distribution is as follows:

$$\lambda = \frac{\chi^2 (\alpha, d. f.)}{2t}$$

where:

 λ = failure rate

 γ 2 = chi-square function

 $\alpha = (100 - \text{confidence level}) / 100$

d.f. = degrees of freedom = 2r + 2 r = number of failures

t = device hours

Chi-square values for 60% and 90% confidence intervals for up to 12 failures are shown below.

Chi-Square Table

	Chi-Square Distril	bution Functio	n
60% Con	60% Confidence Level		idence Level
No. Fails	χ2 Quantity	No. Fails	χ2 Quantity
0	1.833	0	4.605
1	4.045	1	7.779
2	6.211	2	10.645
3	8.351	3	13.362
4	10.473	4	15.987
5	12.584	5	18.549
6	14.685	6	21.064
ensine 7 noite	16.780	500 ty 8 VIII	23.542
8	18.868	8 8	25.989
9 50 10	20.951	9	28.412
10	23.031	10	30.813
11	25.106	sas ynnup b	33.196
12	27.179	12	35.563

The failure rate of semiconductor devices is inherently low. As a result, the industry uses a technique called accelerated testing to assess the reliability of semiconductors. During accelerated tests, elevated stresses are used to produce, in a short period, the same failure mechanisms as would be observed under normal use conditions. The objective of this testing is to identify these failure mechanisms and eliminate them as a cause of failure during the useful life of the product.

Temperature, relative humidity, and voltage are the most frequently used stresses during accelerated testing. Their relationship to failure rates has been shown to follow an Eyring type of equation of the form:

$$\lambda = A \exp(\phi kT) \cdot \exp(B/RH) \cdot \exp(CE)$$

Where A, B, C, ϕ , and k are constants, more specifically B, C, and ϕ are numbers representing the apparent energy at which various failure mechanisms occur. These are called activation energies. "T" is the temperature, "RH" is the relative humidity, and "E" is the electric field. The most familiar form of this equation (shown on following page) deals with the first exponential term that shows an Arrhenius type relationship of the failure rate versus the junction temperature of semiconductors. The junction temperature is related to the ambient temperature through the thermal resistance and power dissipation. Thus, we can test devices near their maximum junction temperatures, analyze the failures to assure that they are the types that are accelerated by temperature and then by applying known acceleration factors, estimate the failure rates for lower junction temperatures.

The Table on the following page shows observed activation energies with references.

a distribution pullback and a Table 1 – Time Dependent Failure Mechanisms in Semiconductor Devices (1994) AMABERT (Applicable to Discrete and Integrated Circuits)

Device Association	Process	Relevant Factors	Accelerating Factors	Typical Activation Energy in eV	Model	Reference
Silicon Oxide Silicon-Silicon Oxide Interface	Surface Charges Inversion, Accumulation	Mobile Ions E/V, T	T, V	1.0 Point normal	Fitch, et al. Peck	1A 2
	Oxide Pinholes	E/V, T	E, T illo ent ni	0.7 - 1.0 (Bipolar) 1.0 (Bipolar)	1984 WRS Hokari, et al.	18 5
serature and the off	Dielectric Breakdown (TDDB)	E/V, T	E, Tososque	0.3-0.4 (MOS) 0.3 (MOS)	Domangue, et al. Crook, D.L.	3 4
a demonstration of	Charge Loss	E, TH RIA	E, T	0.8 (MOS) EPROM	Gear, G.	circuit from
Metallization	Electromigration	T, Jeouber galliamed extension except	J, T	1.0 Large grain Al (glassivated)	Nanda, et al.	6
r specific packages, a	llure. Mai <i>resistance</i> values fo Data Book or Davigo M	Grain Size	(S)	0.5 Small grain Al	Black, J.R.	7 sneriw
otorola sales office.	y or contact your local it. ON ENERGY	Doping	n, including	0.7 Cu-Al/Cu-Si-Al (sputtered)	Black, J.R.	12 T
	Corrosion Chemical Galvanic Electrolytic	Contamination	H, E/V, T	0.6-0.7 (for electrolysis) E/V may have thresholds	Lycoudes, N.E.	8 OUB = AQU = AUB
Bond and Other Mechanical Interfaces	Intermetallic Growth	T, Impurities Bond Strength	maximum "i	1.0 (Au/Al)	Fitch, W.T.	Dy PADC
Various Wafer Fab, Assembly, and Silicon Defects	Metal Scratches Mask Defects, etc. Silicon Defects	T, V	T, V nso (f) n	0.5-0.7 eV 0.5 eV	Howes, et al.	10

V = voltage; E = electric field; T = temperature; J = current density; H = humidity

NO. REFERENCE

- 1A 1.0 eV activation for leakage type failures. Fitch, W.T.; Greer, P.; Lycoudes, N.; "Data to Support 0.001%/1000 Hours for Plastic I/Cs." Case study on linear product shows 0.914 eV activation energy which is within experimental error of 0.9 To 1.3 eV activation energies for reversible leakage (inversion) failures reported in the literature.
- 1B 0.7 To 1.0 eV for oxide defect failures for bipolar structures. This is under investigation subsequent to information obtained from 1984 Wafer Reliability Symposium, especially for bipolar capacitors with silicon nitride as dielectric.
- 1.0 eV activation for leakage type failures.
 Peck, D.S.; "New Concerns About Integrated Circuit Reliability" 1978 Reliability Physics Symposium.
- 3 0.36 eV for dielectric breakdown for MOS gate structures. Domangue, E.; Rivera, R.; Shedard, C.; "Reliability Prediction Using Large MOS Capacitors", 1984 Reliability Physics Symposium.
- 4 0.3 eV for dielectric breakdown. Crook, D.L.; "Method of Determining Reliability Screens for Time Dependent Dielectric Breakdown", 1979 Reliability Physics Symposium.
- 1.0 eV for dielectric breakdown.
 Hokari, Y.; et al.; IEDM Technical Digest, 1982.

- 1.0 eV for large grain Al-Si (compared to line width).
 Nanda, Vangard, Gj-P; Black, J.R.; "Electromigration of Al-Si Alloy Films",
 1978 Reliability Physics Symposium.
- 7 0.5 eV AI, 0.7 eV Cu-AI small grain (compared to line width). Black, J.R.; "Current Limitation of Thin Film Conductor" 1982 Reliability Physics Symposium.
- 8 0.65 eV for corrosion mechanism. Lycoudes, N.E.; "The Reliability of Plastic Microcircuits in Moist Environments", 1978 Solid State Technology.
- 9 1.0 eV for open wires or high resistance bonds at the pad bond due to Au-Al intermetallics.
 Fitch, W.T.; "Operating Life vs Junction Temperatures for Plastic Encapsulated I/C (1.5 mil Au wire)", unpublished report.
- 10 0.7 eV for assembly related defects. Howes, M.G.; Morgan, D.V.; "Peliability and Degradation, Semiconductor Devices and Circuits" John Wiley and Sons, 1981.
- 11 Gear, G.; "FAMOUS PROM Reliability Studies", 1976 Reliability Physics Symposium
- 12 Black, J.R.: unpublished report.
- 13 Motorola Memory Products Division; unpublished report.

THERMAL RESISTANCE

Circuit performance and long-term circuit reliability are affected by die temperature. Normally, both are improved by keeping the junction temperatures low.

Electrical power dissipated in any semiconductor device is a source of heat. This heat source increases the temperature of the die about some reference point, normally the ambient temperature of 25° C in still air. The temperature increase, then, depends on the amount of power dissipated in the circuit and on the net thermal resistance between the heat source and the reference point.

The temperature at the junction depends on the packaging and mounting system's ability to remove heat generated in the circuit from the junction region to the ambient environment. The basic formula for converting power dissipation to estimated junction temperature is:

$$T_{J} = T_{A} + P_{D} (\overline{\theta}_{JC} + \overline{\theta}_{CA})$$
 (1)

or:

$$T_{J} = T_{A} + P_{D}(\overline{\theta}_{JA}) \tag{2}$$

where:

T_J = maximum junction temperature

T_A = maximum ambient temperature

PD = calculated maximum power dissipation, including effects of external loads when applicable

 $\overline{\theta}$ JC = average thermal resistance, junction to case

 $\overline{\theta}_{CA}$ = average thermal resistance, case to ambient

 $\overline{\theta}_{\text{JA}}$ = average thermal resistance, junction to ambient

This Motorola recommended formula has been approved by RADC and DESC for calculating a "practical" maximum operating junction temperature for MIL-M-38510 devices.

Only two terms on the right side of equation (1) can be varied by the user, the ambient temperature and the device case-to-ambient thermal resistance, $\bar{\theta}_{CA}$. (To some extent the device power dissipation can also be controlled, but under

recommended use the supply voltage and loading dictate a fixed power dissipation.) Both system air flow and the package mounting technique affect the $\overline{\theta}_{CA}$ thermal resistance term. $\overline{\theta}_{JC}$ is essentially independent of air flow and external mounting method, but is sensitive to package material, die bonding method, and die area.

For applications where the case is held at essentially a fixed temperature by mounting on a large or temperature controlled heat sink, the estimated junction temperature is calculated by:

$$T_{i,l} = T_{C} + P_{D}(\overline{\theta}_{i,l}C) \tag{3}$$

where T_C = maximum case temperature and the other parameters are as previously defined.

AIR FLOW

Air flow over the packages (due to a decrease in $\overline{\theta}_{CA}$) reduces the thermal resistance of the package, therefore permitting a corresponding increase in power dissipation without exceeding the maximum permissible operating junction temperature.

For thermal resistance values for specific packages, see the Motorola Data Book or Design Manual for the appropriate device family or contact your local Motorola sales office.

ACTIVATION ENERGY

Determination of activation energies is accomplished by testing randomly selected samples from the same population at various stress levels and comparing failure rates due to the same failure mechanism. The activation energy is represented by the slope of the curve relating to the natural logarithm of the failure rate to the various stress levels.

In calculating failure rates, the comprehensive method is to use the specific activation energy for each failure mechanism applicable to the technology and circuit under consideration. A common alternative method is to use a single activation energy value for the "expected" failure mechanism(s) with the lowest activation energy.

RELIABILITY STRESS TESTS

The following are brief descriptions of the reliability tests commonly used in the reliability monitoring program. Not all of the tests listed are performed by each product division. Other tests may be performed when appropriate.

AUTOCLAVE (aka, PRESSURE COOKER)

Autoclave is an environmental test which measures device resistance to moisture penetration and the resultant effects of galvanic corrosion. Autoclave is a highly accelerated and destructive test.

Typical Test Conditions: $T_A = 121^\circ$ C, $r_h = 100\%$, p = 1 atmosphere (15 psig), t = 24 to 96 hours

Common Failure Modes: Parametric shifts, high leakage and/or catastrophic

Common Failure Mechanisms: Die corrosion or contaminants such as foreign material on or within the package materials. Poor package sealing

HIGH HUMIDITY HIGH TEMPERATURE BIAS (H3TB, H3TRB, or THB)

This is an environmental test designed to measure the moisture resistance of plastic encapsulated devices. A bias is applied to create an electrolytic cell necessary to accelerate corrosion of the die metallization. With time, this is a catastrophically destructive test.

Typical Test Conditions: $T_A = 85^\circ$ C to 95° C, rh = 85% to 95%, Bias = 80% to 100% of Data Book max. rating, t = 96 to 1750 hours

Common Failure Modes: Parametric shifts, high leakage and/or catastrophic

Common Failure Mechanisms: Die corrosion or contaminants such as foreign material on or within the package materials. Poor package sealing

HIGH TEMPERATURE GATE BIAS (HTGB)

This test is designed to electrically stress the gate oxide under a bias condition at high temperature.

Typical Test Conditions: T_A = 150° C, Bias = 80% of Data Book max. rating, t = 120 to 1000 hours

Common Failure Modes: Parametric shifts in gate leakage and gate threshold voltage

Common Failure Mechanisms: Random oxide defects and ionic contamination

Military Reference: MIL-STD-750, Method 1042

HIGH TEMPERATURE REVERSE BIAS (HTRB)

The purpose of this test is to align mobile ions by means of temperature and voltage stress to form a high-current leakage path between two or more junctions.

Typical Test Conditions: $T_A = 85^{\circ}$ C to 150° C, Bias = 80% to 100% of Data Book max. rating, t = 120 to 1000 hours

Common Failure Modes: Parametric shifts in leakage and gain

Common Failure Mechanisms: Ionic contamination on the surface or under the metallization of the die Military Reference: MIL-STD-750, Method 1039

HIGH TEMPERATURE STORAGE LIFE (HTSL)

High temperature storage life testing is performed to accelerate failure mechanisms which are thermally activated through the application of extreme temperatures.

Typical Test Conditions: $T_A = 70^{\circ} \text{ C}$ to 200° C , no bias, t = 24 to 2500 hours

Common Failure Modes: Parametric shifts in leakage and gain

Common Failure Mechanisms: Bulk die and diffusion defects

Military Reference: MIL-STD-750, Method 1032

INTERMITTENT OPERATING LIFE (IOL)

The purpose of this test is the same as SSOL in addition to checking the integrity of both wire and die bonds by means of thermal stressing.

Typical Test Conditions: $T_A = 25^{\circ}$ C, Pd = Data Book maximum rating, $T_{On} = T_{Off} = \Delta$ of 50° C to 100° C, t = 42 to 30000 cycles

Common Failure Modes: Parametric shifts and catastrophic

Common Failure Mechanisms: Foreign material, crack and bulk die defects, metallization, wire and die bond defects

Military Reference: MIL-STD-750, Method 1037

MECHANICAL SHOCK

This test is used to determine the ability of the device to withstand a sudden change in mechanical stress due to abrupt changes in motion as seen in handling, transportation, or actual use.

Typical Test Conditions: Acceleration = 1500 g's, Orientation = X₁, Y₁, Y₂ plane, t = 0.5 msec, Blows = 5 **Common Failure Modes**: Open, short, excessive leakage, mechanical failure

Common Failure Mechanisms: Die and wire bonds, cracked die, package defects

Military Reference: MIL-STD-750, Method 2015

MOISTURE RESISTANCE

The purpose of this test is to evaluate the moisture resistance of components under temperature/humidity conditions typical of tropical environments.

Typical Test Conditions: $T_A = -10^{\circ} \text{ C}$ to 65° C, $r_A = 80\%$ to 98%, t = 24 hours/cycle, cycle = 10

Common Failure Modes: Parametric shifts in leakage and mechanical failure

Common Failure Mechanisms: Corrosion or contaminants on or within the package materials. Poor package sealing

Military Reference: MIL-STD-750, Method 1021

SOLDERABILITY

The purpose of this test is to measure the ability of device leads/terminals to be soldered after an extended period of storage (shelf life).

Typical Test Conditions: Steam aging = 8 hours, Flux = R, Solder = Sn60, Sn63

Common Failure Modes: Pin holes, dewetting, nonwetting

Common Failure Mechanisms: Poor plating, contaminated leads

Military Reference: MIL-STD-750, Method 2026

SOLDER HEAT

This test is used to measure the ability of a device to withstand the temperatures as may be seen in wave soldering operations. Electrical testing is the endpoint criterion for this stress.

Typical Test Conditions: Solder Temperature = 260° C, t = 10 seconds

Common Failure Modes: Parameter shifts, mechanical failure

Common Failure Mechanisms: Poor package design Military Reference: MIL-STD-750, Method 2031

STEADY STATE OPERATING LIFE (SSOL)

The purpose of this test is to evaluate the bulk stability of the die and to generate defects resulting from manufacturing aberrations that are manifested as time and stress-dependent failures.

Typical Test Conditions: $T_A = 25^{\circ} C$, $P_D = Data Book maximum rating, <math>t = 16$ to 1000 hours

Common Failure Modes: Parametric shifts and catastrophic

Common Failure Mechanisms: Foreign material, crack die, bulk die, metallization, wire and die bond defects Military Reference: MIL-STD-750, Method

TEMPERATURE CYCLING (AIR TO AIR)

The purpose of this test is to evaluate the ability of the device to withstand both exposure to extreme temperatures and transitions between temperature extremes. This testing will also expose excessive thermal mismatch between materials.

Typical Test Conditions: $T_A = -65^{\circ} \text{ C to } 200^{\circ} \text{ C}$, cycle -10 to 4000

Common Failure Modes: Parametric shifts and catastrophic

Common Failure Mechanisms: Wire bond, cracked or lifted die and package failure

Military Reference: MIL-STD-750, Method 1051

THERMAL SHOCK (LIQUID TO LIQUID)

The purpose of this test is to evaluate the ability of the device to withstand both exposure to extreme temperatures and sudden transitions between temperature extremes. This testing will also expose excessive thermal mismatch between materials

Typical Test Conditions: $T_A = 0^{\circ}$ C to 100° C, cycle = 20 to 300

Common Failure Modes: Parametric shifts and catastrophic

Common Failure Mechanisms: Wire bond, cracked or lifted die and package failure

Military Reference: MIL-STD-750, Method 1056

VARIABLE FREQUENCY VIBRATION

This test is used to examine the ability of the device to withstand deterioration due to mechanical resonance.

Typical Test Conditions: Peak acceleration = 20 g's, Frequency range = 20 Hz to 20 KHz, t = 48 minutes. **Common Failure Modes**: Open, short, excessive leakage, mechanical failure

Common Failure Mechanisms: Die and wire bonds, cracked die, package defects

Military Reference: MIL-STD-750, Method 2056

STATISTICAL PROCESS CONTROL

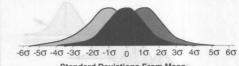
Communication Power & Signal Technologies Group (CPSTG) is continually pursuing new ways to improve product quality. Initial design improvement is one method that can be used to produce a superior product. Equally important to outgoing product quality is the ability to produce product that consistently conforms to specification. Process variability is the basic enemy of semiconductor manufacturing since it leads to product variability. Used in all phases of Motorola's product manufacturing, STATISTICAL PROCESS CONTROL (SPC) replaces variability with predictability. The traditional philosophy in the semiconductor industry has been adherence to the data sheet specification. Using SPC methods assures the product will meet specific process requirements throughout the manufacturing cycle. The emphasis is on defect prevention, not detection. Predictability through SPC methods requires the manufacturing culture to focus on constant and permanent improvements. Usually these improvements cannot be bought with state-of-the-art equipment or automated factories. With quality in design, process and material selection, coupled with manufacturing predictability, Motorola can produce world class products.

The immediate effect of SPC manufacturing is predictability through process controls. Product centered and distributed well within the product specification benefits Motorola with fewer rejects, improved yields and lower cost. The direct benefit to Motorola's customers includes better incoming quality levels, less inspection time and ship-to-stock capability. Circuit performance is often dependent on the cumulative effect of component variability. Tightly controlled component distributions give the customer greater circuit predictability. Many customers are also converting to just-in-time (JIT) delivery programs. These programs require improvements in cycle time and yield predictability achievable only through SPC techniques. The benefit derived from SPC helps the manufacturer meet the customer's expectations of higher quality and lower cost product.

Ultimately, Motorola will have Six Sigma capability on all products. This means parametric distributions will be centered within the specification limits with a product distribution of plus or minus Six Sigma about mean. Six Sigma capability, shown graphically in Figure 1, details the benefit in terms of yield and outgoing quality levels. This compares a centered distribution versus a 1.5 sigma worst case distribution shift.

New product development at Motorola requires more robust design features that make them less sensitive to minor variations in processing. These features make the implementation of SPC much easier.

A complete commitment to SPC is present throughout Motorola. All managers, engineers, production operators, supervisors and maintenance personnel have received multiple training courses on SPC techniques. Manufacturing has identified numerous wafer processing and assembly steps considered critical to the processing of semiconductor products. Processes, controlled by SPC methods, that have shown significant improvement are in the diffusion, photolithography and metallization areas.



Standard Deviations From Mean

Distribution Centered
At ± 3 σ 2700 ppm defective

99.73% yield At \pm 4 \odot 63 ppm defective 99.9937% yield

At \pm 5 σ 0.57 ppm defective 99.999943% yield

At ± 6 σ 0.002 ppm defective 99.9999998% yield

Distribution Shifted \pm 1.5

66810 ppm defective

93.32% yield 6210 ppm defective

99.379% yield 233 ppm defective 99.9767% yield

3.4 ppm defective 99.99966% yield

Figure 1 – AOQL and Yield from a Normal Distribution of Product With 6σ Capability

To better understand SPC principles, brief explanations have been provided. These cover process capability, implementation and use.

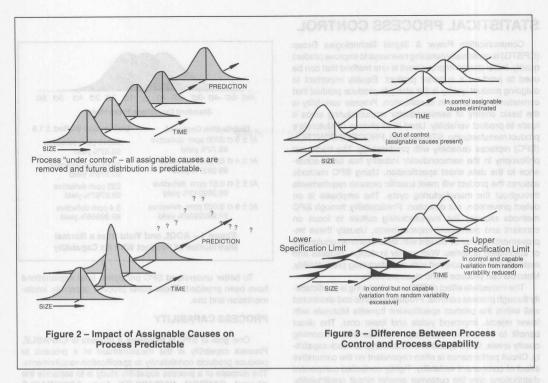
PROCESS CAPABILITY

One goal of SPC is to ensure a process is CAPABLE. Process capability is the measurement of a process to produce products consistently to specification requirements. The purpose of a process capability study is to separate the inherent RANDOM VARIABILITY from ASSIGNABLE CAUSES. Once completed, steps are taken to identify and eliminate the most significant assignable causes. Random variability is generally present in the system and does not fluctuate. Sometimes, these are considered basic limitations associated with the machinery, materials, personnel skills or manufacturing methods. Assignable cause inconsistencies relate to time variations in yield, performance or reliability.

Traditionally, assignable causes appear to be random due to the lack of close examination or analysis. Figure 2 shows the impact on predictability that assignable cause can have. Figure 3 shows the difference between process control and process capability.

A process capability study involves taking periodic samples from the process under controlled conditions. The performance characteristics of these samples are charted against time. In time, assignable causes can be identified and engineered out. Careful documentation of the process is key to accurate diagnosis and successful removal of the assignable causes. Sometimes, the assignable causes will remain unclear requiring prolonged experimentation.

Elements which measure process variation control and capability are Cp and Cpk respectively. Cp is the specification width divided by the process width or Cp = (specification width) / 6 σ . Cpk is the absolute value of the closest specification value to the mean, minus the mean, divided by half the process width or Cpk = I closest specification $-\frac{\nabla}{X}/3\sigma$.



At Motorola, for critical parameters, the process capability is acceptable with a Cpk = 1.50 with continual improvement our goal. The desired process capability is a Cpk = 2 and the ideal is a Cpk = 5. Cpk, by definition, shows where the current production process fits with relationship to the specification limits. Off center distributions or excessive process variability will result in less than optimum conditions

SPC IMPLEMENTATION AND USE

CPSTG uses many parameters that show conformance to specification. Some parameters are sensitive to process variations while others remain constant for a given product line. Often, specific parameters are influenced when changes to other parameters occur. It is both impractical and unnecessary to monitor all parameters using SPC methods. Only critical parameters that are sensitive to process variability are chosen for SPC monitoring. The process steps affecting these critical parameters must be identified also. It is equally important to find a measurement in these process steps that correlates with product performance. This is called a critical process parameter.

Once the critical process parameters are selected, a sample plan must be determined. The samples used for measurement are organized into RATIONAL SUBGROUPS of approximately 2 to 5 pieces. The subgroup size should be such that variation among the samples within the subgroup remain small. All samples must come from the same source e.g., the same mold press operator, etc.. Subgroup data should be collected at appropriate time intervals to detect variations in the process. As the process begins to show

improved stability, the interval may be increased. The data collected must be carefully documented and maintained for later correlation. Examples of common documentation entries would include operator, machine, time, settings, product type, atc.

Once the plan is established, data collection may begin. The data collected will generate \overline{X} and R values that are plotted with respect to time. \overline{X} refers to the mean of the values within a given subgroup, while R is the range or greatest value minus least value. When approximately 20 or more \overline{X} and R values have been generated, the average of these values is computed as follows:

$$\overline{X} = (\overline{X} + \overline{X}2 + \overline{X}3 + ...)/K$$

 $\overline{R} = (R1 + R2 + R3 + ...)/K$

where K = the number of subgroups measured.

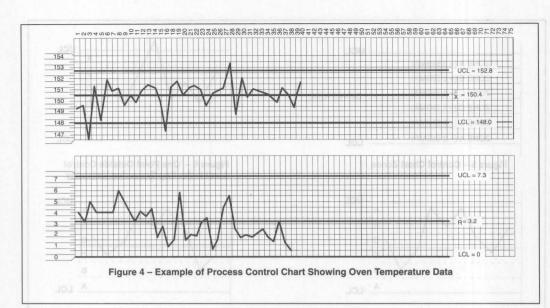
The values of \overline{X} and \overline{R} are used to create the process control chart. Control charts are the primary SPC tool used to signal a problem. Shown in Figure 4, process control charts show \overline{X} and \overline{R} values with respect to time and concerning reference to upper and lower control limit values. Control limits are computed as follows:

R upper control limit = $UCL_R = D4 \overline{R}$

R lower control limit = LCLR = D3 R

 \overline{X} upper control limit = UCL $\overline{X} = X + A2 \overline{R}$

 \overline{X} lower control limit = LCL \overline{X} = \overline{X} - A2 \overline{R}



Where D4, D3 and A2 are constants varying by sample size, with values for sample sizes from 2 to 10 shown in the following partial table:

* For sample sizes below 7, the LCLR would technically be a negative number; in those cases there is no lower control limit; this means that for a subgroup size 6, six "identical" measurements would not be unreasonable.

Control charts are used to monitor the variability of critical process parameters. The R chart shows basic problems with piece to piece variability related to the process. The X chart can often identify changes in people, machines, methods, etc. The source of the variability can be difficult to find and may require experimental design techniques to identify assignable causes.

Some general rules have been established to help determine when a process is **OUT-OF-CONTROL**. Figure 5 shows a control chart subdivided into zones A, B, and C corresponding to 3 sigma, 2 sigma, and 1 sigma limits respectively. In Figure 6 through Figure 8 four of the tests that can be used to identify excessive variability and the presence of assignable causes are shown. As familiarity with a given process increases, more subtle tests may be employed successfully.

Once the variability is identified, the cause of the variability must be determined. Normally, only a few factors have a significant impact on the total variability of the process. The importance of correctly identifying these factors is stressed in the following example. Suppose a process variability depends on the variance of five factors A, B, C, D and E. Each has a variance of 5, 3, 2, 1 and 0.4 respectively. Since:

$$\sigma$$
 tot = $\sqrt{\sigma} A^2 + \sigma B^2 + \sigma C^2 + \sigma D^2 + \sigma E^2$

$$\sigma \text{ tot} = \sqrt{5^2 + 3^2 + 2^2 + 1^2 + (0.4)^2} = 6.3$$

Now if only D is identified and eliminated then;

$$\sigma$$
 tot = $\sqrt{5^2 + 3^2 + 2^2 + (0.4)^2} = 6.2$

This results in less than 2% total variability improvement. If B, C and D were eliminated, then;

$$\sigma \cot = \sqrt{5^2 + (0.4)^2} = 5.02$$

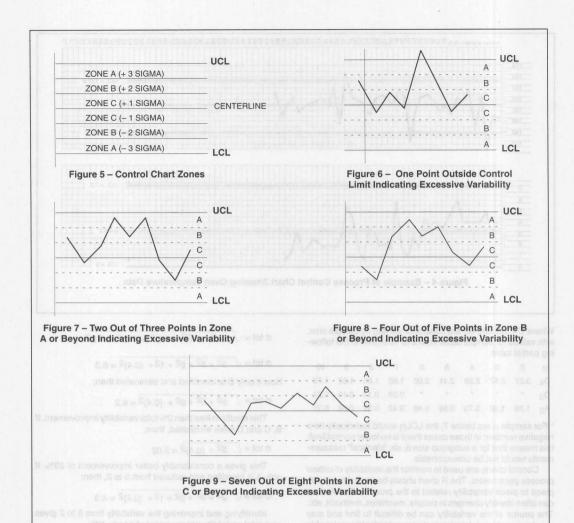
This gives a considerably better improvement of 23%. If only A is identified and reduced from 5 to 2, then;

$$\sigma \text{ tot} = \sqrt{2^2 + 3^2 + 2^2 + 1^2 + (0.4)^2} = 4.3$$

Identifying and improving the variability from 5 to 2 gives us a total variability improvement of nearly 40%.

Most techniques may be employed to identify the primary assignable cause(s). Out-of-control conditions may be correlated to documented process changes. The product may be analyzed in detail using best versus worst part comparisons or Product Analysis Lab equipment. Multi-variance analysis can be used to determine the family of variation (positional, critical or temporal). Lastly, experiments may be run to test theoretical or factorial analysis. Whatever method is used, assignable causes must be identified and eliminated in the most expeditious manner possible.

After assignable causes have been eliminated, new control limits are calculated to provide a more challenging variability criteria for the process. As yields and variability improve, it may become more difficult to detect improvements because they become much smaller. When all assignable causes have been eliminated and the points remain within control limits for 25 groups, the process is said to be in a state of control.



SUMMARY

Motorola is committed to the use of STATISTICAL PROCESS CONTROLS. These principles, used throughout manufacturing, have already resulted in many significant

improvements to the processes. Continued dedication to the SPC culture will allow Motorola to reach the Six Sigma and zero defect capability goals. SPC will further enhance the commitment to **TOTAL CUSTOMER SATISFACTION**.

DEPLACEMENT DEVICES

Castian	MM30002				
Section	170				
					921514
SNAGS	MM4005				
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125012					
Devices	MPFB9				
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REPLACEMENT DEVICES

Device	Replacement Part
2N4404	
2N5058	2N4927
2N5223	MPS6521
2N5440	
2N5458	
2N5459	
2N5484	
2N5485	
2N5638	
2N706A	2N2369A
2N869A	
BC107C	BC107B
BC108A	BC108B
BC108C	BC108B
BC109A	BC109C
BC109B	BC109C
BC141-16	BC141-10
BC309	BC309B
BCW31LT1	
BCW60CLT1	BCW60BLT1
BCW61ALT1	BCW61BLT1

Device	Replacement Part
BCW71LT1	
BCY58VIII	
BCY58X	
BCY59VII	BCY59VIII
BCY78IX	
BCY78VIII	75
BCY79VII	BCY79VIII
BDB01D	BDB01C
BDB02D	BDB02C
BDC02D	
BDC06	
BF244C	BF244B
BF246	BF246A
BF247	
BF247A	
BF247C	
BF256	BF256B
BF259	2N4927
BF491	sheets in the
BSS78	bna eTETA and
CV9507	2N2904A

Device	Replacement Part
J109	
J110	
MM3002	
MM3005	mailan
MM3007	HAHAD
MM4003	
MM4005	2N4033
MM44209	906109
MM6427	2N6427
MPF89	marina
MPS3568	MPS8099
MPS4249	MPS3906
MPS6534	2N4402
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